



Project Area 2

River Basin Groups D and E

Bacteria Impairments

TMDL

Texas Commission on Environmental Quality
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Purpose of Today's Meeting

- Background: Review historical *E. coli*/Fecal Coliform data for San Antonio River and Salado Creek
- Monitoring: Review recent data for San Antonio River and Salado Creek
- Modeling: Review modeling approach and draft results
- Discuss next phase



Part I: Project Background



Introduction

- Section 303 (d) of the Clean Water Act requires states to identify water bodies that do not meet applicable water quality standards. This is known as the 303 (d) list.
- Pursuant to the Clean Water Act, and development of the 303 (d) list, the TCEQ is responsible for development of TMDL's.
- Due to elevated bacteria indicators, specifically fecal coliform or E. coli., Segments 1901 & 1911 of the San Antonio River as well as segments 1910A & 1910 of Waltzem and Salado Creeks (respectively) were selected for assessment in an area known as Project Area 2 – Basin Groups D and E.



What is a TMDL (Total Maximum Daily Load)?

- Establishes the maximum amount of an impairing substance, or stressor, that a waterbody can assimilate and still meet Water Quality Standards
- allocate that load among pollutant contributors
- are a tool for implementing State water quality standards and are based on the relationship between pollution sources and in-stream water quality conditions



What are Water Quality Standards?

- Serve two (2) purposes:
 - they establish water quality goals for a waterbody
 - they provide a regulatory basis for controls beyond technologically based limits



What are Criteria?

- Criteria are water quality conditions which are to be met in order to support and protect designated uses.
- Criteria are expressed as the number of “colony forming units” of bacteria per 100 milliliters (ml) of water.
- Indicator bacteria, although not generally pathogenic, are indicative of potential contamination by feces of warm blooded animals.



Project Segments

- San Antonio River Basin:
 - Salado Creek Segment 1910
 - Walzem Creek Segment 1910A
 - Upper San Antonio River Segment 1911
 - Lower San Antonio River Segment 1901
- Placed on the 2000 §303(d) list because bacteria exceeded the segment specific criteria of 126 colonies per 100 ml (geometric mean) and 394 colonies per 100 ml (single grab).
- Designated Uses
- Contact Recreation



TMDL Development

- Segment is listed on the federal Clean Water Act Section 303 (d) list
- Selection of Pollutant for TMDL
- Initiate TMDL Project
- Data Collection – Compile data about current water quality conditions, collect additional data
- Data Assessment – Quantify impacts and sources (point, non-point, natural background, atmospheric deposition)



TMDL Development, continued

- TMDL Allocation – Identify a quantifiable water quality target for each constituent
- Implementation Plan – Comprehensive strategy for restoring the beneficial uses of the water body
- Draft TMDL Report
- TCEQ Review / Public Comment
- TCEQ Approval / EPA Approval
- Implementation



Stakeholder Involvement

- Improve the quality and quantity of contributions to TMDL projects
- Ensure that state government considers the local perspective in its decisions
- Lead to consensus-based solutions
- Encourage open dialogue on water quality issues



What is E. coli?

- Abbreviated name of the bacterium in the Family Enterobacteriaceae named Escherichia (Genus) coli (Species).
- E. coli and other kinds of bacteria within our intestines are necessary for us to develop, operate properly, and remain healthy.
- E. coli along with other species of bacteria, provide our bodies with many necessary vitamins, for example K and B-complex vitamins. These vitamins are absorbed through our intestines, where the bacteria reside.



How does E. coli get in the water?



- E. coli comes from human and animal wastes. During precipitation, E. coli may be washed into creeks, rivers, streams, lakes, or groundwater and ultimately may end up in drinking water.



Point Source Pollution



- Point Source - "Point Source" means any discernible, confined, and discrete conveyance from which pollutants are or may be discharged.

- Examples include:
 - pipe
 - ditch
 - channel
 - tunnel
 - conduit
 - well
 - landfill
 - concentrated animal feeding operation, etc.



Non-point Source Pollution



Non-point Source – “Non-Point Source” pollution occurs when rainfall or sprinkler runoff gathers manure, oil, grease, litter, fertilizer and other toxic substances and washes them into storm drains, creeks and rivers.



Suspect Pollutant Sources



- Wastewater Treatment Plants
- Confined Animal Feedlot Operations (CAFO's)
- On-Site Sewage Facilities (OSSF's)
- Domestic Animal Feces
- Wild Animal Feces
- Storm Water Runoff
- Agriculture Practices



Salado Creek Assessment

- 1996-2001 record for E. coli , 9 of 16 stations indicated nonsupport
- 1996-2001 record for Fecal Coliform , 12 of 16 stations indicated nonsupport
- lower 24 miles of Segment 1910 not supporting



Salado *E. coli* Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100	STATUS	COVERAGE
12877	NE Loop 410	7	2	94	no concern	1 mi
15643	SH 368	58	13	225	not supporting	<1 mi
12876	SH 368	5	5	2962	primary concern	<1 mi
12875	Eisenhaur	59	11	131	not supporting	1 mi
12874	Rittiman	4	0	129	primary concern	<1 mi
15642	Holbrook	56	16	212	not supporting	1 mi
12872	Pershing	65	10	113	fully supporting	1 mi
12871	IH 35	57	9	108	fully supporting	<1 mi



Salado *E. Coli* Data - Cont'd (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100	STATUS	COVERAGE
15644	Pletz Pk	59	12	143	not supporting	<1 mi
12870	Gembler	25	4	125	fully supporting	1 mi
15645	Commerce	59	11	169	not supporting	1 mi
15646	MLK Pk	99	31	220	not supporting	1.5 mi
12868	Rigsby	63	21	203	not supporting	2 mi
15647	E. Southcross	58	9	159	not supporting	1.5 mi
12864	Loop 13	69	14	184	not supporting	2.5 mi
12862	Goliad	120	17	114	fully supporting	1.5 mi



Salado Fecal Coliform Data (1996-2001)

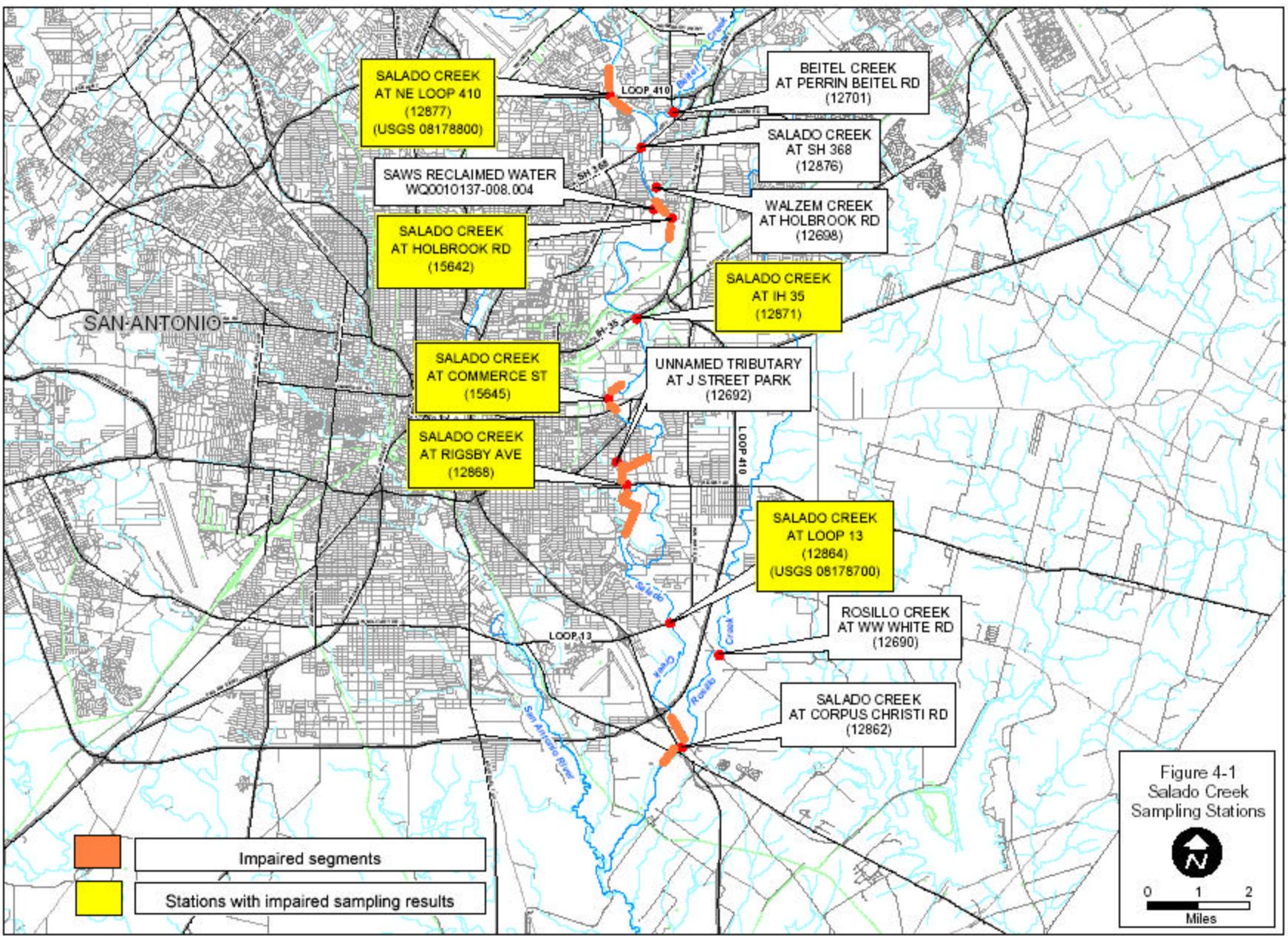
STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12878	Los Patios	1	0	320	not asses	<1 mi
12877	NE Loop 410	17	13	2124	not supporting	1 mi
15643	SH 368	60	29	439	not supporting	<1 mi
12876	SH 368	5	5	8226	primary concern	<1 mi
12875	Eisenhauer	61	24	260	not supporting	1 mi
12874	Rittiman	4	1	263	primary concern	<1 mi
15642	Holbrook	58	30	543	not supporting	1 mi
12872	Pershing	71	15	176	fully supporting	1 mi
12871	IH 35	59	14	208	not supporting	<1 mi



Salado Coliform Data - Cont'd

(1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN	STATUS	COVERAGE
15644	Pletz Pk	60	22	269	not supporting	<1 mi
12870	Gembler	26	7	248	not supporting	<1 mi
15645	Commerce	61	30	415	not supporting	1.5 mi
15646	MLK Pk	104	52	449	not supporting	2 mi
12868	Rigsby	67	30	462	not supporting	<1 mi
15733	Commanche Pk	2	0	215	not asses	1 mi
15647	E Southcross	60	19	311	not supporting	1.5 mi
12864	Loop 13	73	27	347	not supporting	2.5 mi
12862	Goliad	127	26	180	fully supporting	1.5 mi
12861	Southton	1	0	40	not asses	





USAR Assessment

- 1996-2001 record for E. coli , 1 of 9 stations indicated nonsupport
- 1996-2001 record for Fecal Coliform , 9 of 20 stations indicated nonsupport
- upper portion and lower portion of Segment 1911 not supporting



Upper San Antonio River *E. coli* Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12912	Hildebrand	8	3	227	primary concern	<1 mi
12904	Alamo St	5	1	266	primary concern	1 mi
14256	Mitchell St	26	9	263	not supporting	<1 mi
12897	Loop 410	5	0	37	no concern	<1 mi
12894	Blue Wing	5	2	199	primary concern	1 mi
16731	Medina confl	19	0	63	fully supporting	<1 mi
12889	IH 37	6	0	45	no concern	1 mi
12883	Dietz Rd	5	0	123	no concern	1 mi
12879	FM 791	12	0	76	fully supporting	<1 mi



Upper San Antonio River Fecal Coliform Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12912	Hildebrand	26	14	469	not supporting	2 mi
12904	Alamo St	33	19	865	not supporting	2.5 mi
14220	Lone Star	4	4	779	primary concern	1 mi
14256	Mitchell St	48	39	1720	not supporting	2.5 mi
15308	700 m d/s Loop 13	8	2	332	primary concern	2.5 mi
15310	1.2 km d/s Loop 13	5	0	93	no concern	1 mi
12902	Mission Dam	5	1	171	no concern	1 mi
12899	Padre Rd	16	7	67	not supporting	4 mi
12897	Loop 410	27	10	261	not supporting	2 mi
12894	Blue Wing	21	13	452	not supporting	3 mi



USAR Fecal Coliform Data – Cont'd

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
12894	Blue Wing	21	13	452	not supporting	3 mi
16731	Medina confl	19	2	131	fully supporting	2 mi
12890	Medina	6	4	446	primary concern	0.75 mi
12889	IH 37	20	3	146	not supporting	2.5 mi
12886	FM 1604	15	5	327	not supporting	6 mi
12885	Calaveras	15	3	180	fully supporting	6.5 mi
12884	Labatt Rd	21	2	128	fully supporting	1.5 mi
12883	Dietz Rd	20	3	181	fully supporting	2.5 mi
12882	FM 536	14	2	124	fully supporting	5.5 mi
12880	FM 541	15	4	259	not supporting	8 mi
12879	FM 791	30	5	147	fully supporting	4 mi

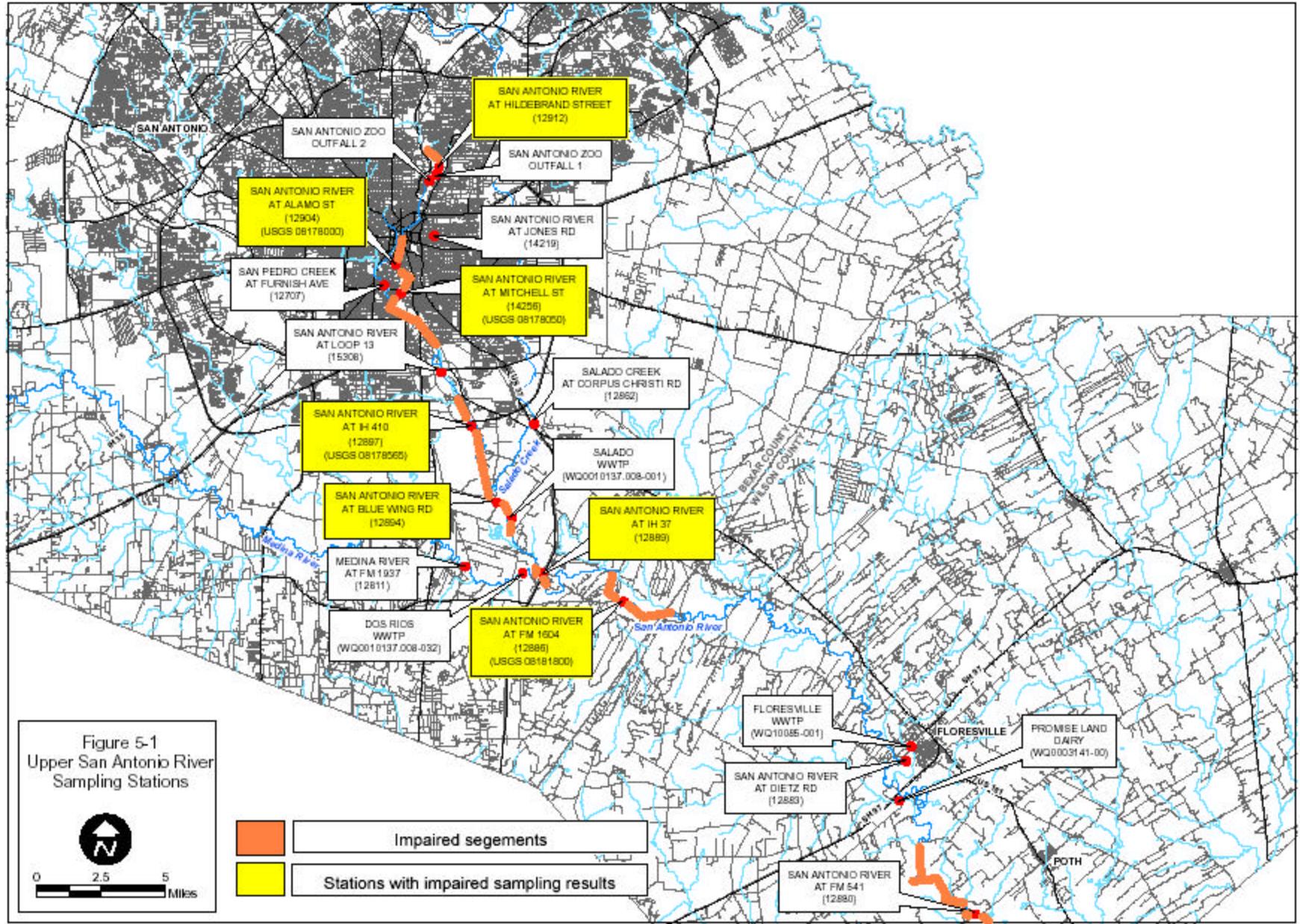


Figure 5-1
Upper San Antonio River
Sampling Stations





LSAR Assessment

- 1996-2001 record for E. coli , 3 of 5 stations indicated nonsupport
- 1996-2001 record for Fecal Coliform , 3 of 5 stations indicated nonsupport
- upper portion and lower portion of Segment 1901 not supporting



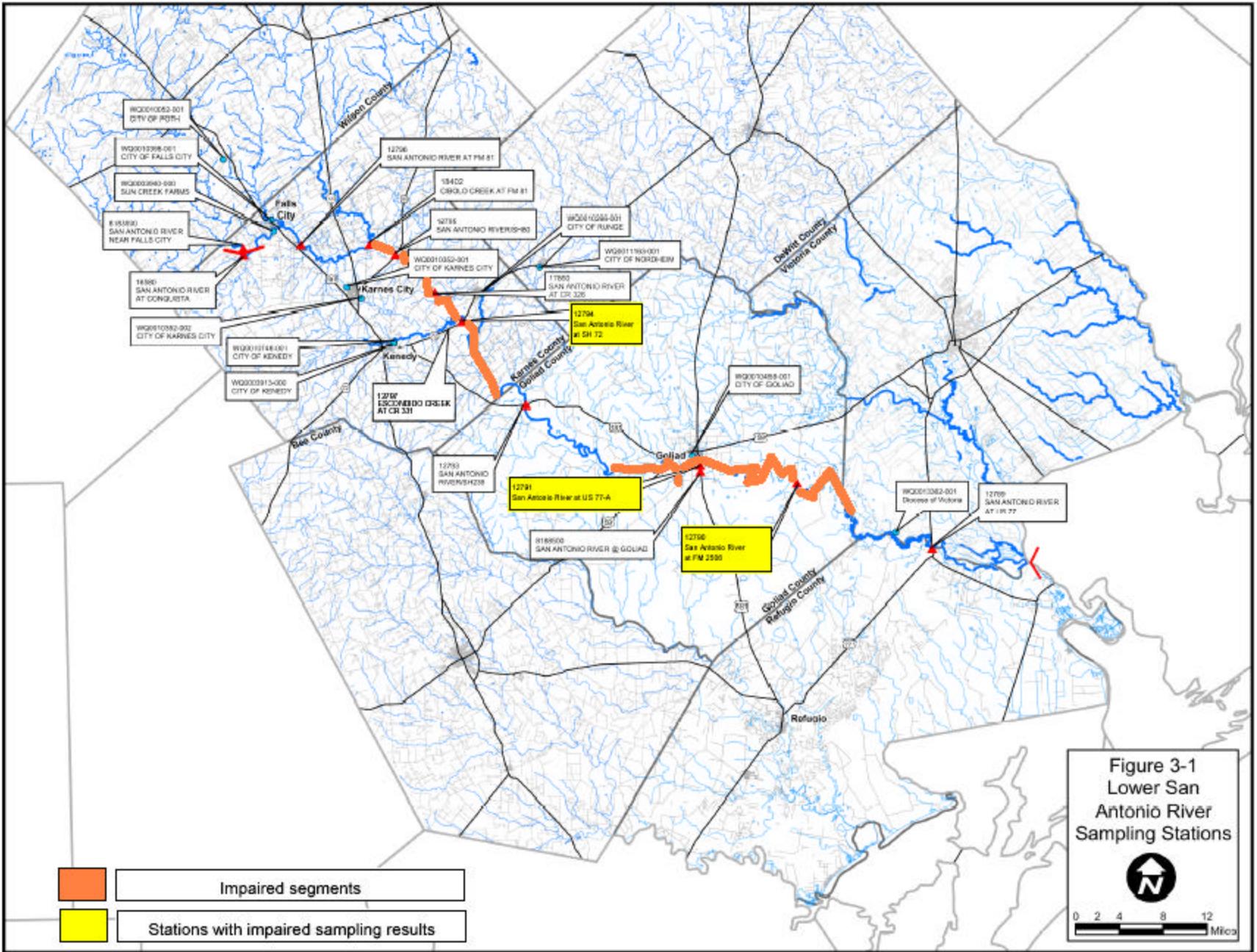
Lower San Antonio River E. coli Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100ML	STATUS	COVERAGE
16580	at Conquista	4	0	94	no concern	FM 791 to Cibolo Ck, 19 mi
12794	at SH 72	13	2	153	not supporting	Cibolo Ck to 2 mi N of Hondo Ck, 25 mi
12793	at SH 239	4	0	107	no concern	2 mi N of Hondo Ck to unnamed trib near Lott Cem., 25 mi
12791	at US 77-A and 183	17	3	198	not supporting	unnamed trib near Lott Cem. To Manahuilla Ck, 25 mi
12790	at FM 2506	22	5	133	not supporting	Manahuilla Ck to Goliad/Refugio Cty line, 25 mi



Lower San Antonio Fecal Coliform Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100ML	STATUS	COVERAGE
16580	at Conquista	4	0	129	no concern	FM 791 to Cibolo Ck, 19 mi
12794	at SH 72	14	4	224	not supporting	Cibolo Ck to 2 mi N of Hondo Ck, 25 mi
12793	at SH 239	4	0	144	no concern	2 mi N of Hondo Ck to unnamed trib near Lott Cem., 25 mi
12791	at US 77-A and 183	18	6	268	not supporting	unnamed trib near Lott Cem. To Manahuilla Ck, 25 mi
12790	at FM 2506	26	10	268	not supporting	Manahuilla Ck to Goliad/Refugio Cty line, 25 mi





Part II: Monitoring Results



Recent Phase – Salado Creek

- 6 Routine Sampling Events
 - 8 Mainstem Stations
 - 1 Tributary Station
- 1 Baseflow Sampling Event
 - 8 Mainstem Stations
 - 4 Tributary Station
 - 1 Point Source
- 1 Runoff Sampling Event
 - 8 Mainstem Stations
 - 4 Tributary Stations
 - 1 Point Source



Monitoring Plan Details – Salado Ck.

Description	Station ID	General Assessment Monitoring						Modeling Support						BST
		Routine Testing			Baseflow Sampling			Runoff Sampling			Sediment			(TN)
		E. coli	Fecal Coliform	Field Parameters (T, D.O., pH, Cond, Cl ₂ -Res, Flow Queen, Flow Severity)	Water Chemistry (NH ₃ -N, DOP, TSS, TOC)	E. coli	Field Parameters (T, D.O., pH, Cond, Cl ₂ -Res, Flow Queen, Flow Severity)	Water Chemistry (NH ₃ -N, DOP, TSS, TOC, TN, TP, CBOD ₅)	E. coli	Field Parameters (T, D.O., pH, Cond, Cl ₂ -Res, Flow Queen, Flow Severity)	Water Chemistry (NH ₃ -N, DOP, TSS, TOC, TN, TP, CBOD ₅)	E. coli	Sediment Chemistry (TN, TP, Percent Solids)	(TN)
Main Stem														
SALADO CREEK AT NE LOOP 410	12877	6	0	6	0	3	3	0	5	5	0	1	0	
SALADO CREEK AT SH 368	12876	6	0	6	0	3	3	0	5	5	0	1	0	80
SALADO CREEK OFF HOLBROOK RD	15642	6	0	6	0	3	3	0	5	5	0	1	0	
SALADO CREEK AT IH 35	12871	6	0	6	0	3	3	0	5	5	0	1	0	
COMMERCE ST	15645	6	0	6	0	3	3	0	5	5	0	1	0	80
SALADO CREEK AT RIGSBY AVE	12868	6	0	6	0	3	3	0	5	5	0	1	0	
SALADO CREEK AT LOOP 13	12864	6	0	6	0	3	3	0	5	5	0	1	0	80
SALADO CREEK AT GOLIAD ROAD	12862	6	0	6	0	3	3	0	5	5	0	1	0	
Tributaries														
BEITEL CREEK AT LOW WATER CROSSING	12701	0	0	0	0	3	3	0	5	5	0	1	0	
WALZEM CREEK AT HOLBROOK ROAD	12698	6	0	6	0	3	3	0	5	5	0	1	0	80
UNNAMED TRIBUTARY OF SALADO CREEK IN J STREET PARK	12692	0	0	0	0	3	3	0	5	5	0	1	0	
ROSILLO CREEK AT W.W. WHITE ROAD	12690	0	0	0	0	3	3	0	5	5	0	1	0	
Wastewater Discharges														
SAWS RECLAIMED WATER DISCHARGE (PERMIT WQ0010137-008.004)	N/A	0	0	0	0	3	3	0	5	5	0	0	0	



Recent Phase – USAR

- 6 Routine Sampling Events
 - 11 Mainstem Stations
 - 2 Point Sources
- 1 Baseflow Sampling Events
 - 11 Mainstem Stations
 - 3 Tributary Stations
 - 5 Point Sources
- 1 Runoff Sampling Event
 - 11 Mainstem stations
 - 3 Tributary stations
 - 6 Point sources



Monitoring Plan Details - USAR

Description	Routine				Baseflow				Runoff				Sediment		BST
	E. coli	Fecal Coliform	Field Parameters (T, DO, pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	Water Chemistry (NH ₃ N, DOP, TSS, TOC)	E. coli	Field Parameters (T, DO, pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	Water Chemistry (NH ₃ N, DOP, TSS, TOC, TKN, TP, CBOD ₅)	E. coli	Field Parameters (T, DO, pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	Water Chemistry (NH ₃ N, DOP, TSS, TOCTKN, TP, CBOD ₅)	E. coli	Sediment Chemistry (TN, TP Percent Solids)	E. coli Ribotyping *		
Mainstem															
SAN ANTONIO RIVER AT HILDEBRAND	6	0	6	0	3	3	0	5	5	0	1	0	80		
SAN ANTONIO RIVER AT JONES RD	6	0	6	0	3	3	0	5	5	0	1	0			
SAN ANTONIO RIVER AT ALAMO ST	6	0	6	0	3	3	0	5	5	0	1	0			
SAN ANTONIO RIVER AT MITCHELL ST	6	0	6	0	3	3	0	5	5	0	1	0	80		
SAN ANTONIO RIVER LOOP 13	6	0	6	0	3	3	0	5	5	0	1	0			
SAN ANTONIO RIVER AT IH 410	6	0	6	0	3	3	0	5	5	0	1	0	80		
SAN ANTONIO RIVER A BLUE WING RD	6	0	6	0	3	3	0	5	5	0	1	0			
SAN ANTONIO RIVER AT IH 37	6	0	6	0	3	3	0	5	5	0	1	0			
SAN ANTONIO RIVER AT FM 1604	6	0	6	0	3	3	0	5	5	0	1	0			
SAN ANTONIO RIVER AT DIETZ RD	6	0	6	0	3	3	0	5	5	0	1	0	80		
SAN ANTONIO RIVER AT FM 541	6	0	6	0	3	3	0	5	5	0	1	0			



USAR Monitoring Plan Details – cont'd

Description	Routine						Baseflow			Runoff			Sediment		BST
	E. coli	Fecal Coliform	Field Parameters (T, D.O., pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	Water Chemistry (NH3N, DOP, TSS, TOC)	E. coli	Field Parameters (T, D.O., pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	Water Chemistry (NH3N, DOP, TSS, TOC, TKN, TP, CBOD ₅)	E. coli	Field Parameters (T, D.O., pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	Water Chemistry (NH3N, DOP, TSS, TOC, TKN, TP, CBOD ₅)	E. coli	Sediment Chemistry (TN, TP, Percent Solids	E. coli Ribotyping *		
Tributaries															
MEDINA RIVER AT FM 1937	0	0	0	0	3	3	0	5	5	0	1	0			
SALADO CREEK AT OLD CORPUS CHRISTI HWY	0	0	0	0	3	3	0	5	5	0	1	0			
SAN PEDRO CREEK AT FURNISH ST	0	0	0	0	3	3	0	5	5	0	1	0			
Point Sources															
SA ZOO OUTFALL 1	6	0	6	0	3	3	0	5	5	0	0	0			
SA ZOO OUTFALL 2	6	0	6	0	3	3	0	5	5	0	0	0			
SAWS RECLAIMED WATER DISCHARGE (PERMIT WQ0010137-003)	0	0	0	0	3	3	0	5	5	0	0	0			
PROMISED LAND DAIRY (PERMIT WQ0003873-000)	0	0	0	0	3	3	0	5	5	0	0	0			
CITY OF FLORESVILLE (PERMIT WQ0010085-001)	0	0	0	0	3	3	0	5	5	0	0	0			
SAWS - MITCHELL LAKE(PERMIT WQ0010137-001)	0	0	0	0	3	3	0	5	5	0	0	0			
SAWS - DOS RIOS WWTP(PERMIT WQ0010137-003)	0	0	0	0	3	3	0	5	5	0	0	0			
SAWS - SALADO WWTP (PERMIT WQ0010137-008)	0	0	0	0	3	3	0	5	5	0	0	0			
CITY PUBLIC SERVICE (PERMIT WQ0001513-000)	0	0	0	0	3	3	0	5	5	0	0	0			
CITY PUBLIC SERVICE (PERMIT WQ0001515-000)	0	0	0	0	3	3	0	5	5	0	0	0			



Recent Phase – LSAR

- 1 Baseflow Sampling Event
 - 9 Mainstem Stations
 - 2 Tributary Stations
 - 2 Point Sources
- 2 Runoff Sampling Events
 - 4 Mainstem Stations (both events)
 - 2 Tributary Stations (both events)
 - 5 Point Sources (event #1), 4 Point Sources (event #2)



LSAR Monitoring Plan Details

Description	Station ID	E. coli	Modeling Support			
			Baseflow Sampling (TN)		Runoff Sampling (TN)	
			1 Event	2 Events	1 Event	2 Events
Main Stem						
LSAR AT CONQUISTA	16580	3	3	1	0	0
LSAR AT FM 81	12796	3	3	1	10	10
LSAR AT SH 80	12795	3	3	1	0	0
LSAR AT OLD RUNGE RD, CR 326	TBD	3	3	1	0	0
LSAR AT SH 72	12794	3	3	1	10	10
LSAR AT SH 239	12793	3	3	1	0	0
LSAR AT HWY 77A	12791	3	3	1	10	10
LSAR AT FM 2506	12790	3	3	1	0	0
LSAR AT US 77	12789	3	3	1	10	10



LSAR Monitoring Plan Details – cont'd

Description	Station ID	E. coli	Modeling Support			
			Baseflow Sampling (TN) 1 Event		Runoff Sampling (TN) 2 Events	
			Field Parameters (T, DO, pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)	E. coli in Sediment	E. coli	Field Parameters (T, DO, pH, Cond., Cl ₂ -Res., Flow Quan., Flow Severity)
Tributaries						
CIBOLO CR AT FM 81	18402	3	3	1	10	10
ESCONDIDO CREEK AT CR 331	12797	3	3	1	10	10
Point Sources						
CITY OF KENEDY (PERMIT WQ0003913-000)	N/A	3	3	0	10	10
SUN CREEK FARMS (PERMIT WQ0003940-000)	N/A	3	3	0	10	10
CITY OF KARNES CITY (PERMIT WQ0010352-001)	N/A	3	3	0	10	10
CITY OF KARNES CITY (PERMIT WQ0010352-002)	N/A	3	3	0	10	10
CITY OF FALLS CITY (PERMIT WQ0010398-001)	N/A	3	3	0	10	10
CITY OF GOLIAD (PERMIT WQ0010458-001)	N/A	3	3	0	10	10



Bacterial Source Tracking (BST)

- Methods: ERIC-PCR & Automated Ribotyping
 - Genetic fingerprints of *E. coli* strains
 - Genes that code for ribosome RNA
 - Distinguish between different bacterial strains
 - Lab Results from El Paso Agricultural Research and Extension Center, El Paso, Texas



Bacterial Source Tracking (BST)

- Library of Known Bacteria Types (Knowns)
 - Salado Creek/Upper San Antonio River: 500 Samples
 - Lower San Antonio River: 200 Samples



BST Water Samples (Unknowns)

Upper San Antonio River

- Station 12912 – At Hildebrand - # 80 samples
- Station 14256 – At Mitchell St. - # 80 samples
- Station 15308 – Loop 410 - # 80 samples
- Station 12883 – At Dietz Rd. - # 80 samples

Lower San Antonio River

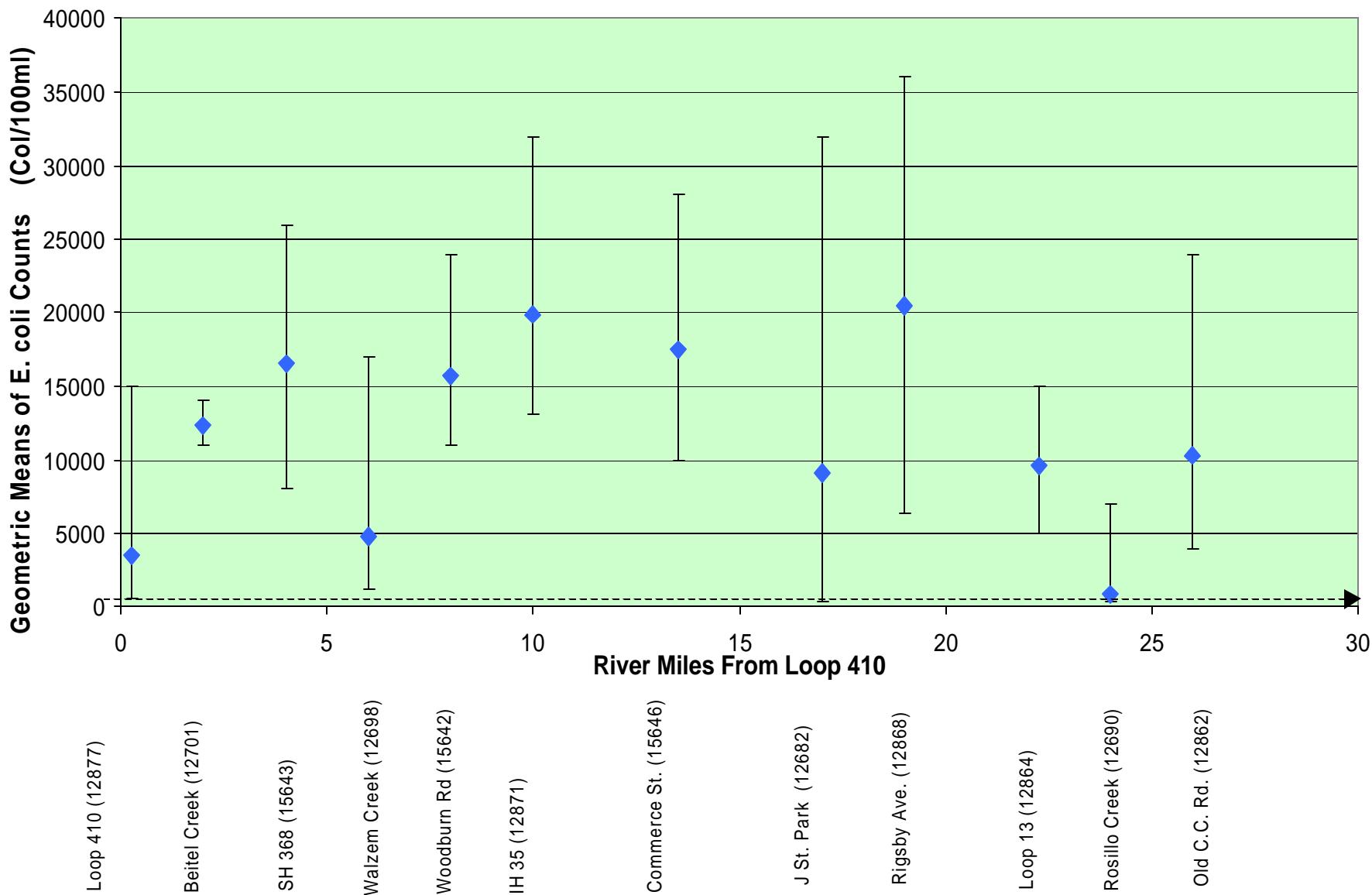
- Station 12794 – At SH 72 - # 90 samples
- Station 12790 – At FM 2506 - # 90 samples

Salado Creek

- Station 12876 – SH 368 - # 80 samples
- Station 12698 – Walzem Creek at Holbrook Rd.- # 83 samples
- Station 15645 – Upstream From Commerce St.- # 84 samples
- Station 12864 – Loop 13 - # 83 samples



Salado Creek Storm Water Survey 4 June 2003





Salado Creek Storm Water Survey – 4 June 2003

● Main Stem

- 8 Stations Sampled
- 8 Stations with geometric means > 126 CFU/100 ml
- 8 Stations with maximums > 394 CFU/100 ml

● Tributaries

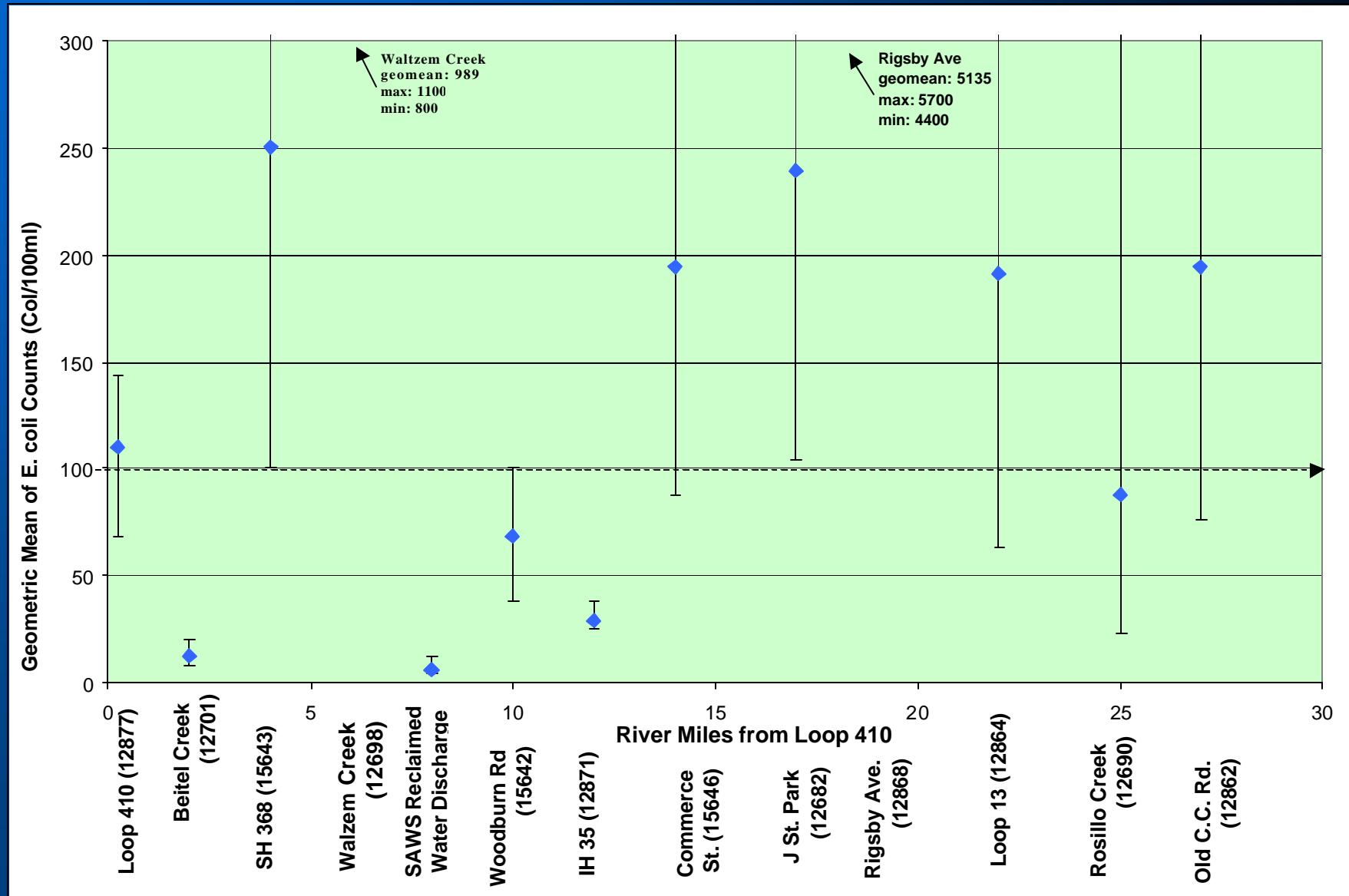
- 4 Stations Sampled
- 4 Stations geometric means > 126 CFU/100 ml
- 4 Stations with maximums > 394 CFU/100 ml

● WWTPs

- 0 WWTPs sampled



Salado Creek Baseflow Survey – 4-5 August 2003





Salado Creek Baseflow Survey – 4-5 August 2004

● Main Stem

- 8 Stations Sampled
- 2 Stations with geometric means > 126 CFU/100 ml
- 2 Stations with maximums > 394 CFU/100 ml

● Tributaries

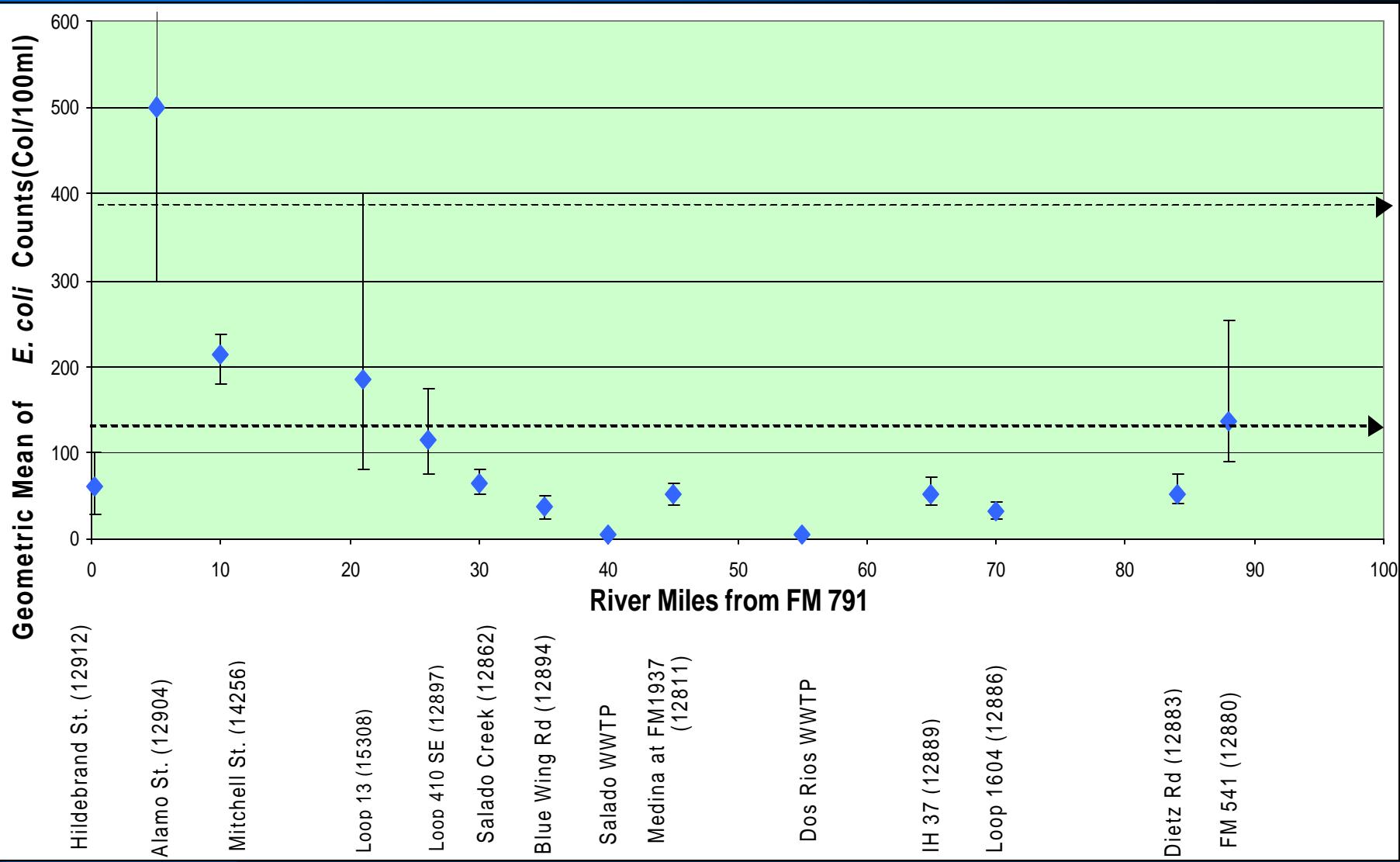
- 4 Stations Sampled
- 2 Stations geometric means > 126 CFU/100 ml
- 1 Stations with maximums > 394 CFU/100 ml

● WWTPs

- 1 WWTPs sampled
- 0 WWTPs with geometric means > 126 CFU/100 ml
- 0 WWTPs with maximums > 394 CFU/100 ml



Upper San Antonio River Baseflow Survey – August 18-19 2003





Upper San Antonio Baseflow Survey – 18-19 August 2003

● Main Stem

- 11 Stations Sampled
- 5 Stations with geometric means > 126 CFU/100 ml
- 3 Stations with maximums > 394 CFU/100 ml

● Tributaries

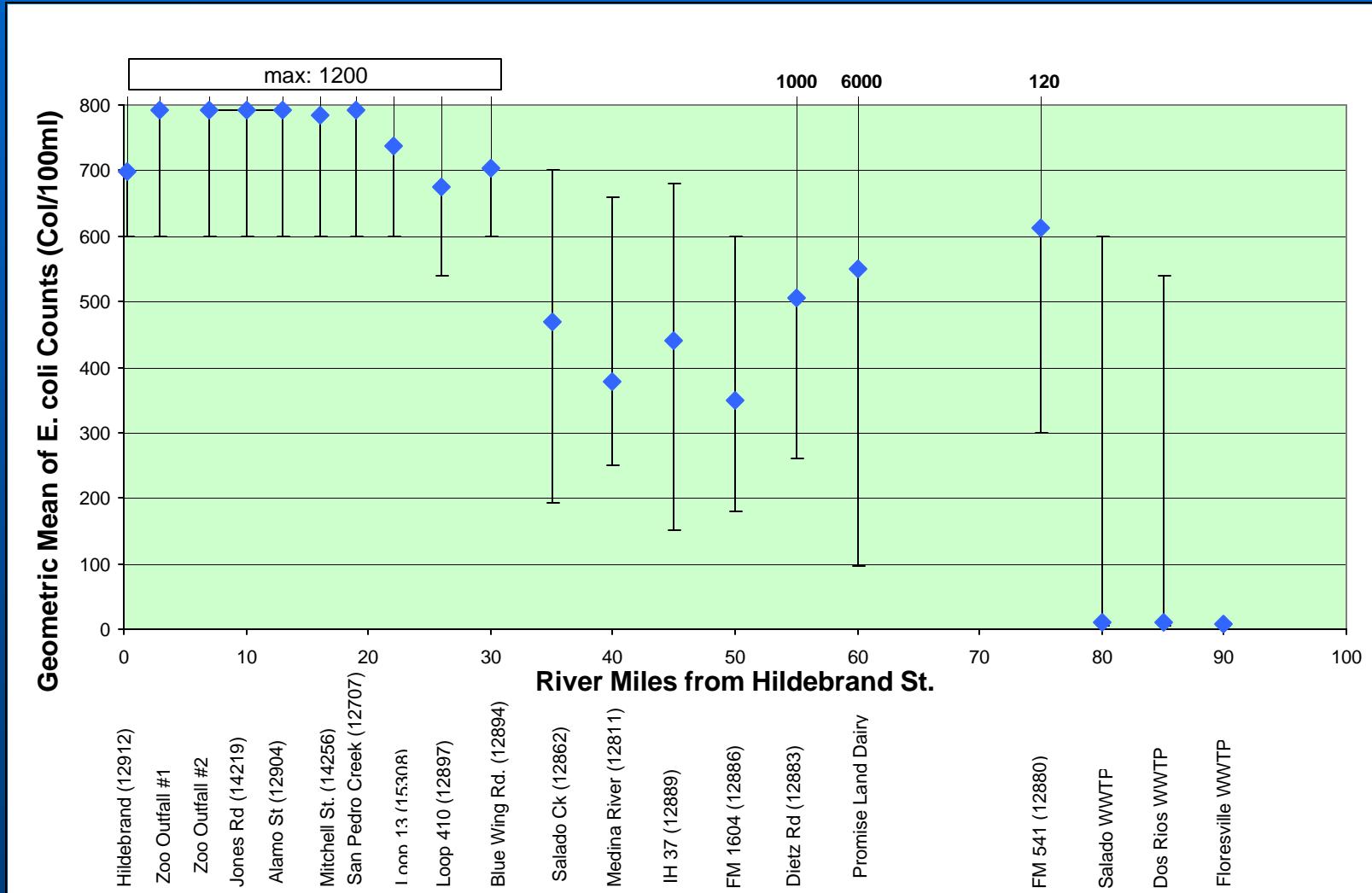
- 3 Stations Sampled
- 1 Station geometric mean > 126 CFU/100 ml
- 1 Station with maximum > 394 CFU/100 ml

● Point Sources

- 3 Point Sources sampled
- 1 Point Sources with geometric means > 126 CFU/100 ml
- 1 Point Sources with maximums > 394 CFU/100 ml



Upper San Antonio River Storm Water Survey - 15-18 July 2003





Upper San Antonio Storm Water Survey – 15-18 July 2003

● Main Stem

- 11 Stations Sampled
- 11 Stations with geometric means > 126 CFU/100 ml
- 11 Stations with maximums > 394 CFU/100 ml

● Tributaries

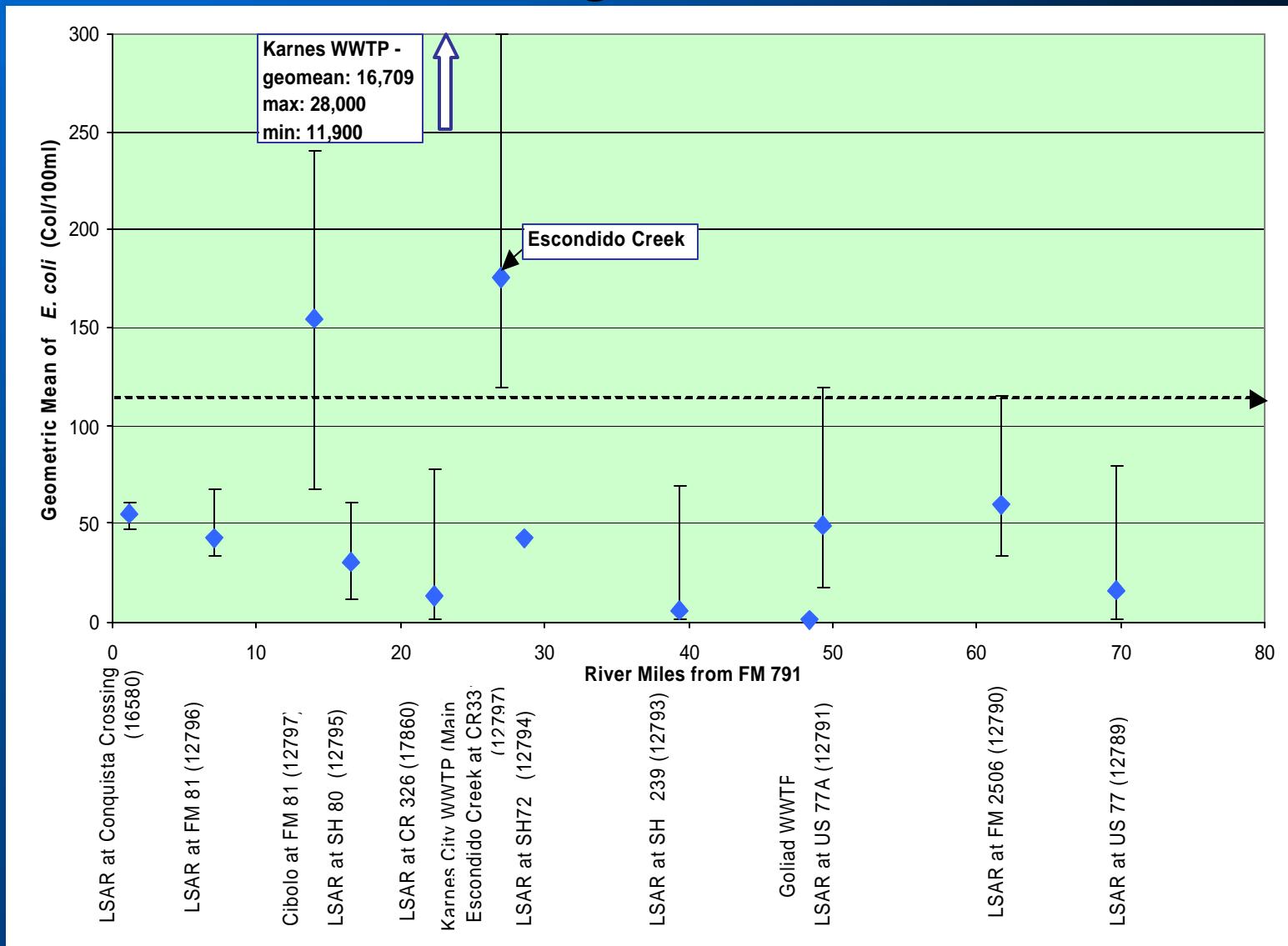
- 3 Stations Sampled
- 3 Stations geometric means > 126 CFU/100 ml
- 3 Stations with maximums > 394 CFU/100 ml

● Point Sources

- 3 Point Sources sampled
- 0 Point Sources with geometric means > 126 CFU/100 ml
- 0 Point Sources with maximums > 394 CFU/100 ml

Lower San Antonio River Baseflow Survey -

3-4 August 2004





Lower San Antonio Baseflow Survey – 3-4 August 2004

● Main Stem

- 9 Stations Sampled
- 0 Stations with geometric means > 126 CFU/100 ml
- 0 Stations with maximums > 394 CFU/100 ml

● Tributaries

- 2 Stations Sampled
- 2 Stations geometric means > 126 CFU/100 ml
- 0 Stations with maximums > 394 CFU/100 ml

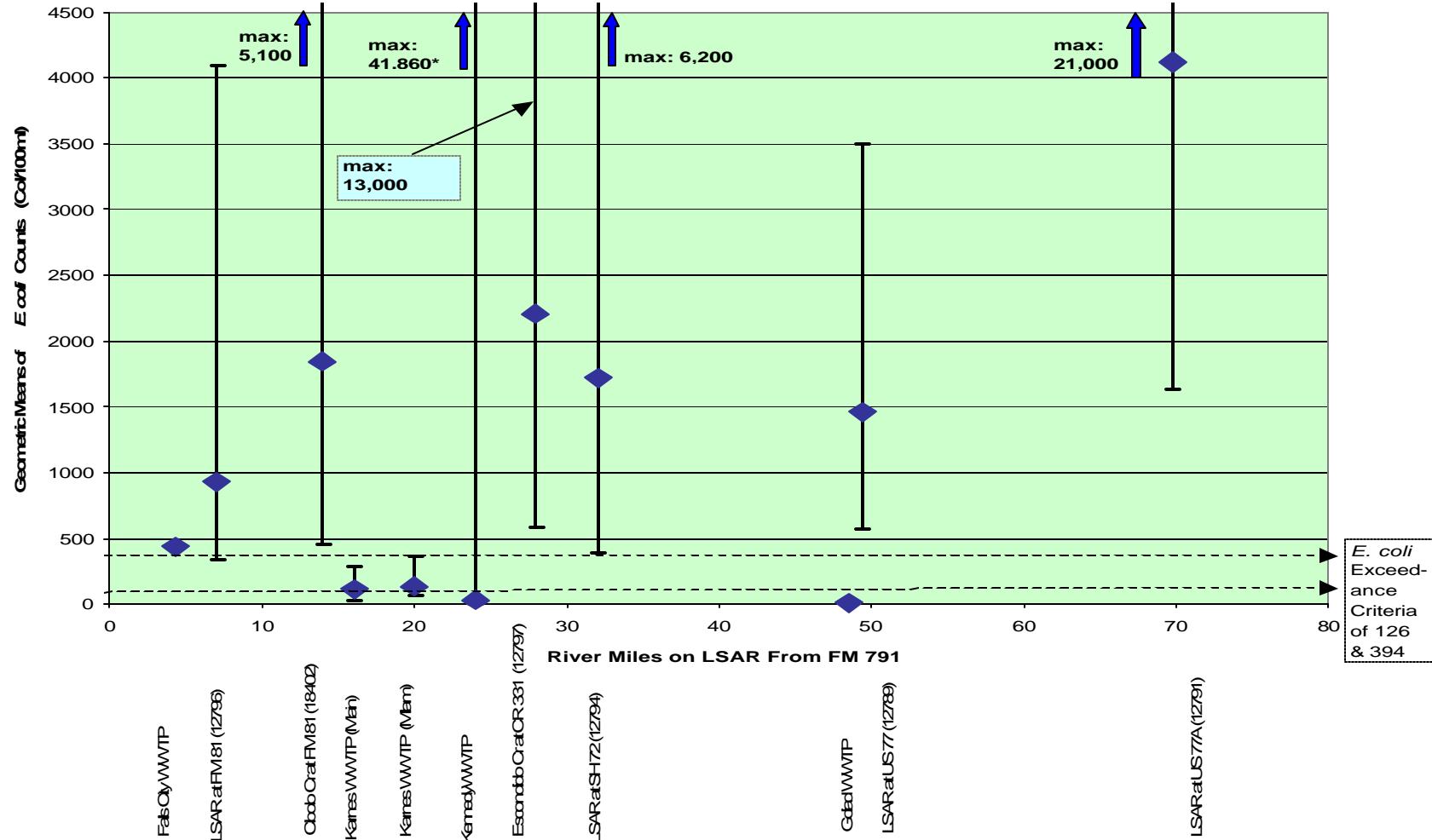
● Waste Water Treatment Plants

- 2 WWTP's sampled
- 1 WWTP's with geometric means > 126 CFU/100 ml
- 1 WWTP's with maximums > 394 CFU/100 ml



Lower San Antonio River Storm Water Event, 24-23 April 2004

Lower San Antonio River Storm Water Event, 24-30 April 2004



Lower San Antonio Storm Survey – 24-30 April 2004



● Main Stem

- 4 Stations Sampled
- 4 Stations with geometric means > 126 CFU/100 ml
- 4 Stations with maximums > 394 CFU/100 ml

● Tributaries

- 2 Stations Sampled
- 2 Stations geometric means > 126 CFU/100 ml
- 2 Stations with maximums > 394 CFU/100 ml

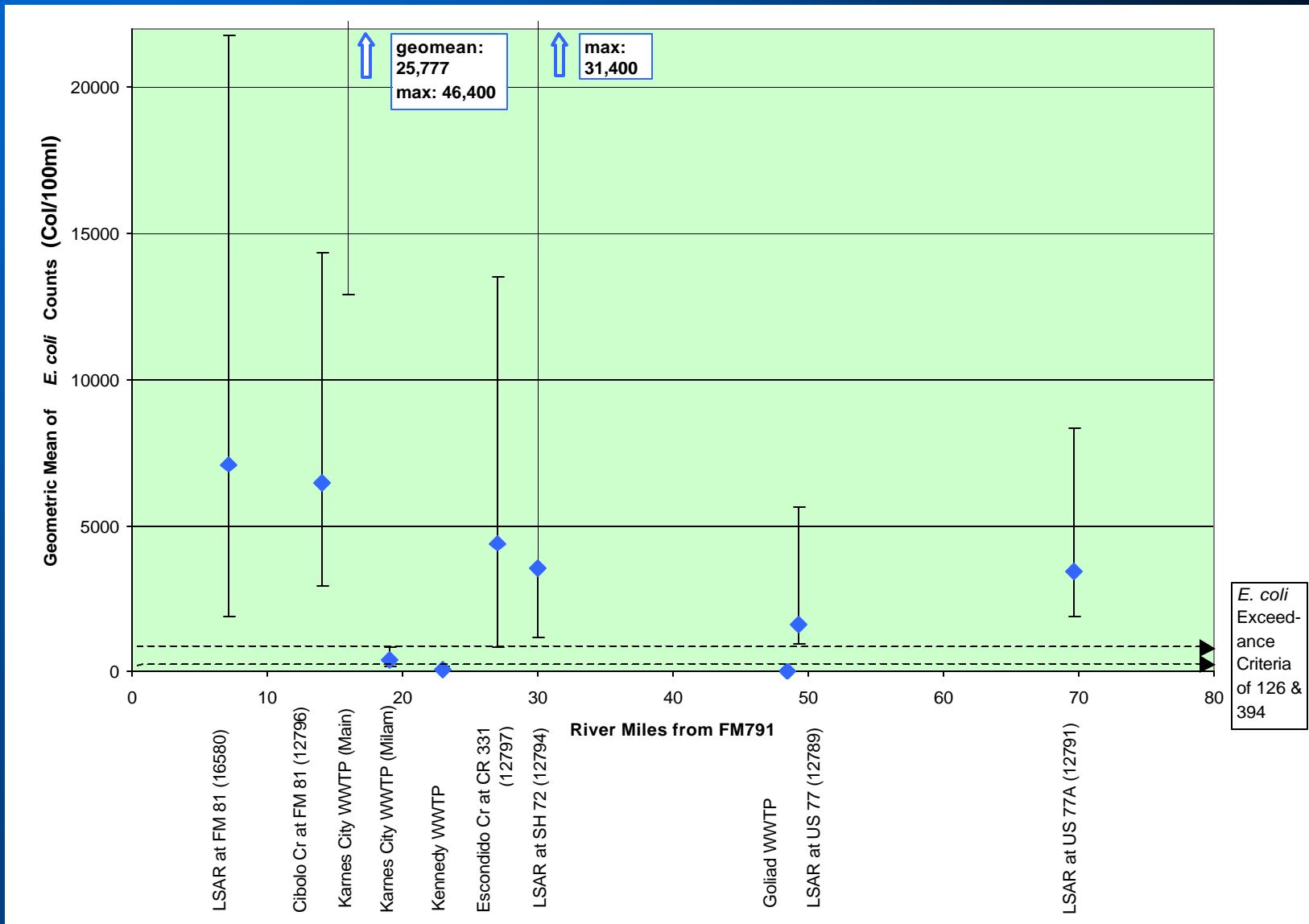
● Waste Water Treatment Plants

- 4 WWTP's sampled
- 1 WWTP's with geometric means > 126 CFU/100 ml
- 1 WWTP's with maximums > 394 CFU/100 ml



Lower San Antonio Storm Survey

17-19 November 2004





Lower San Antonio Storm Survey – 17-19 November 2004

● Main Stem

- 4 Stations Sampled
- 4 Stations with geometric means > 126 CFU/100 ml
- 4 Stations with maximums > 394 CFU/100 ml

● Tributaries

- 2 Stations Sampled
- 2 Stations geometric means > 126 CFU/100 ml
- 2 Stations with maximums > 394 CFU/100 ml

● Waste Water Treatment Plants

- 4 WWTP's sampled
- 1 WWTP's with geometric means > 126 CFU/100 ml
- 1 WWTP's with maximums > 394 CFU/100 ml



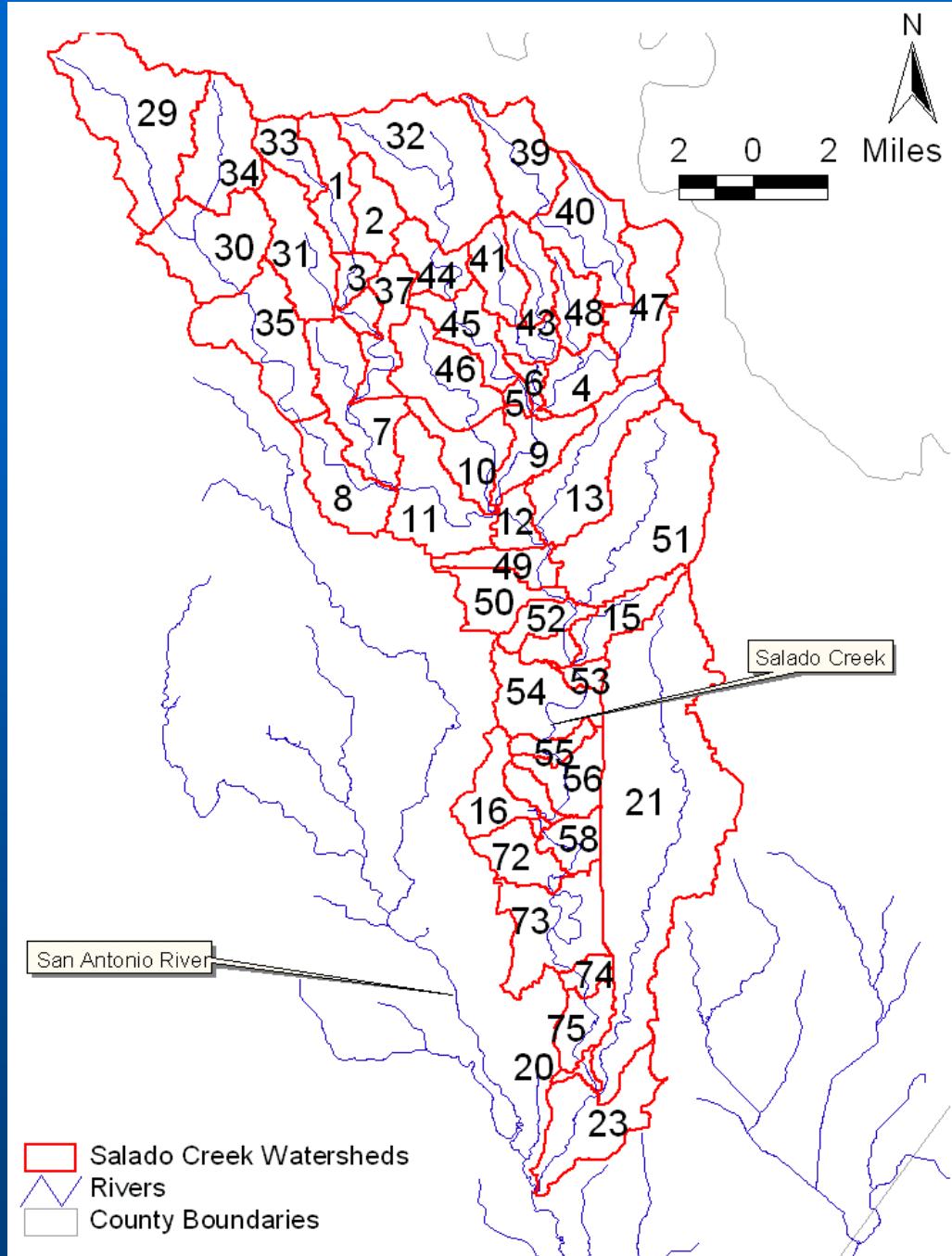
Part III – Modeling

Approach and Draft Results

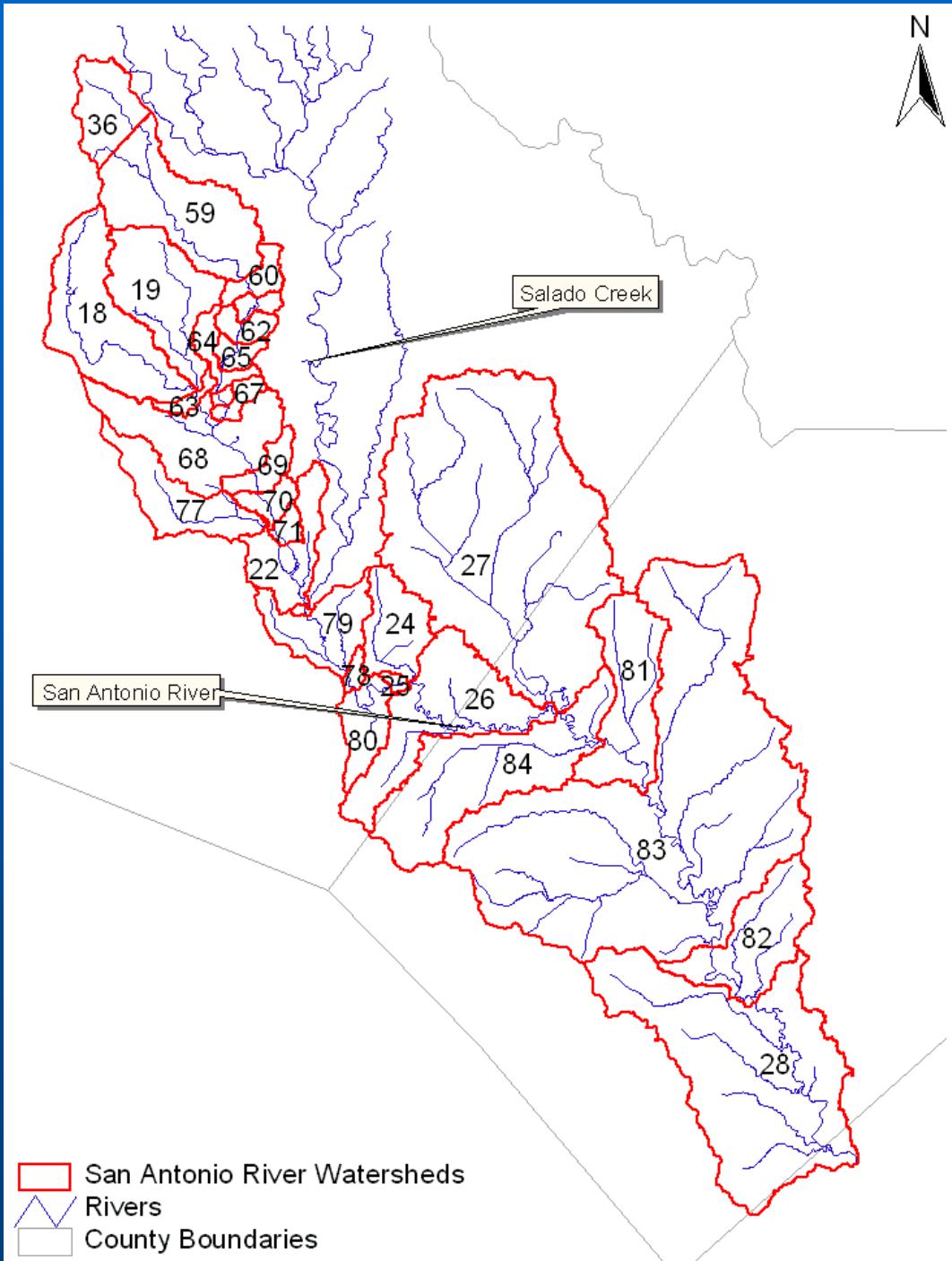


HSPF

- Watershed Modeling System
- Simulation of Hydrology
- Simulation of Point Source Loadings
- Simulation of Nonpoint Source Loadings
- Simulation of Receiving Water Quality



Salado Creek Watersheds

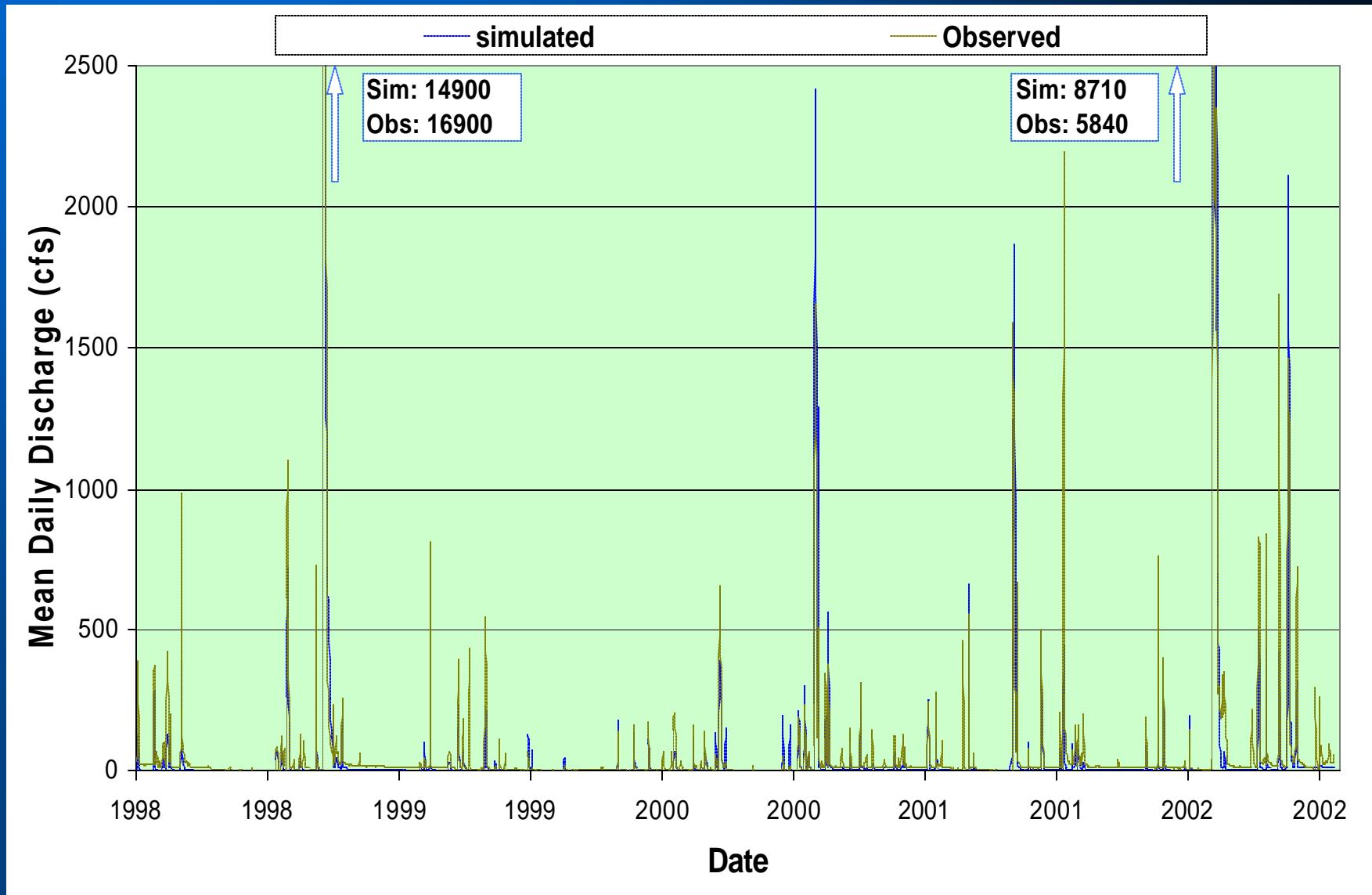


San Antonio River Watersheds



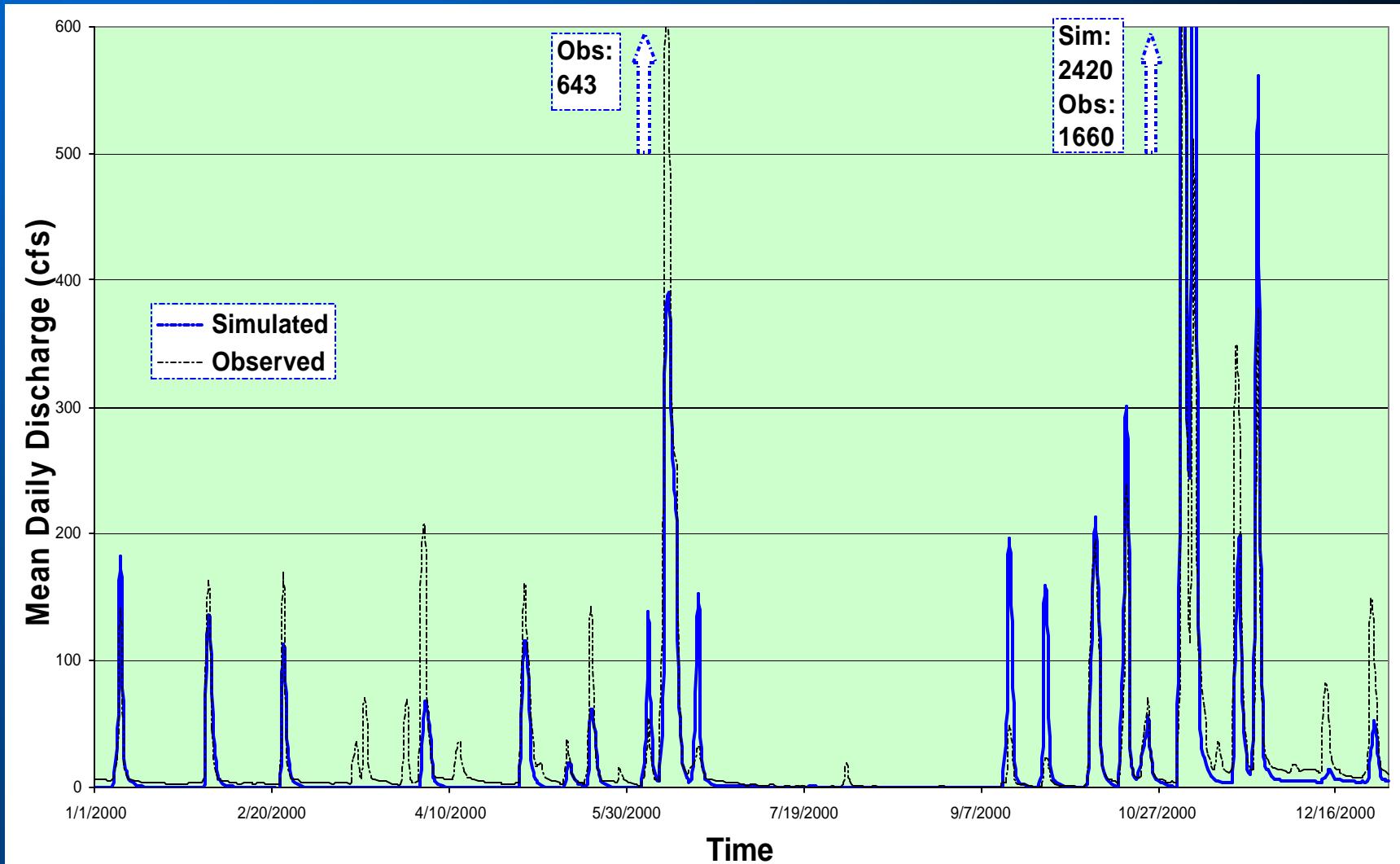
Mean Daily Discharge for Calibration

Years 1998-2002 – Loop 13 - Salado Creek





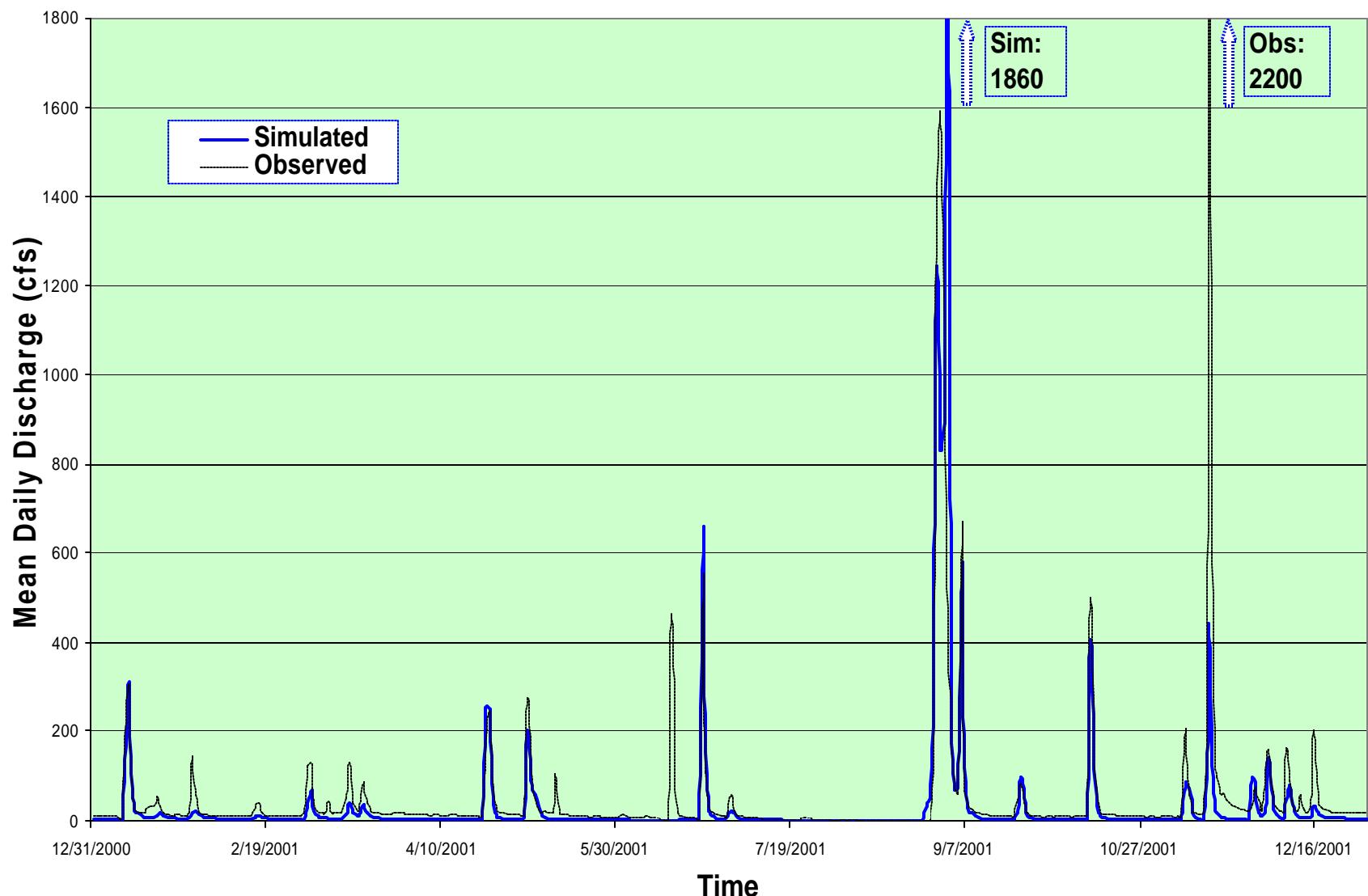
Mean Daily Discharge for Calibration Year 2000 – Loop 13 - Salado Creek



Mean Daily Discharge for Calibration



Year 2001 – Loop 13 - Salado Creek





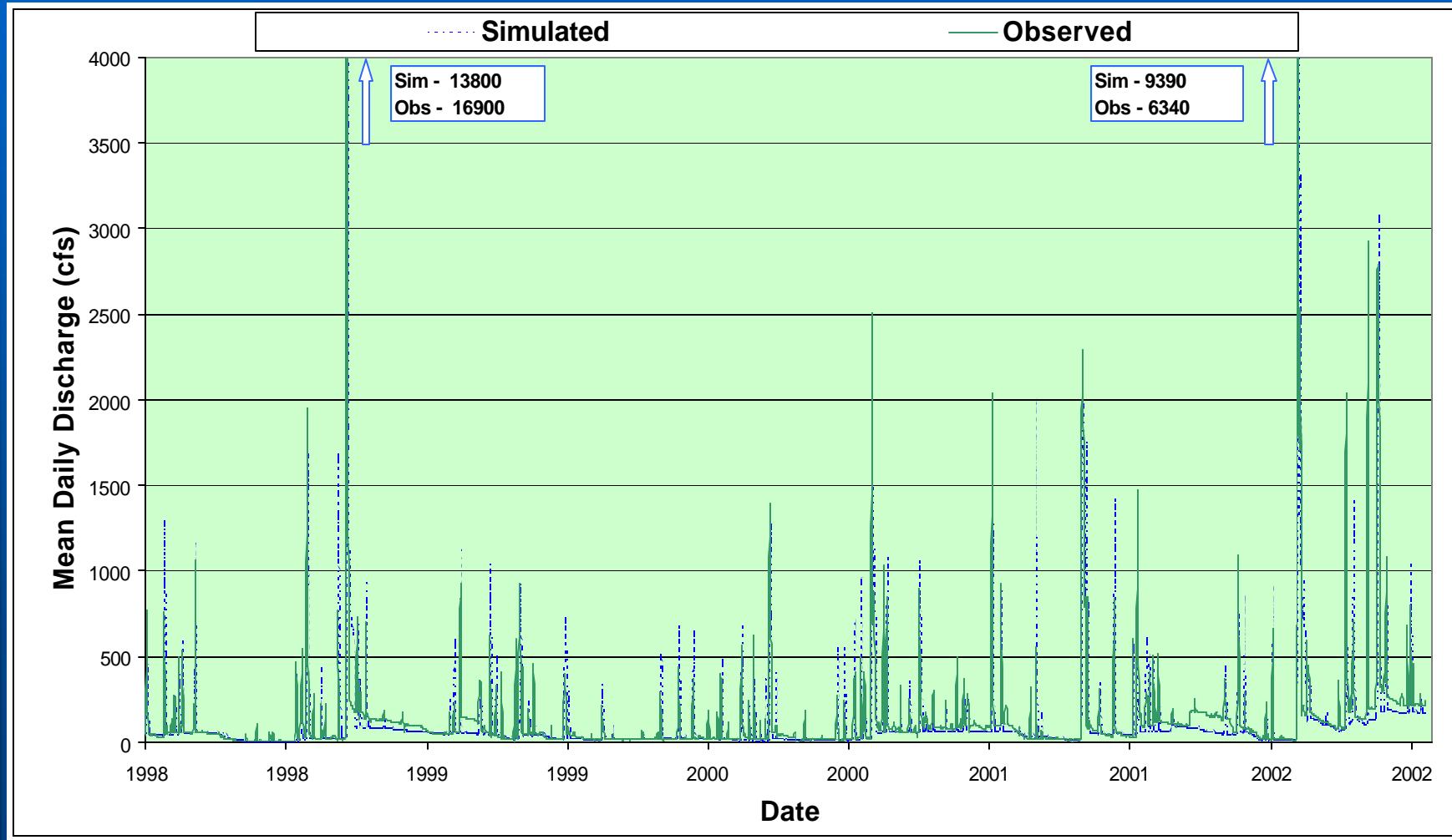
HSPF Calibration Output

Salado Creek, Loop 13

	Simulated	Observed
Total Runoff (in)	26.600	24.431
Total of Highest 10% Flows	21.390	20.323
Total of Lowest 50% Flows	0.840	0.855
Evapotranspiration	30.030	80.490
Total Storm Volume	9.790	9.119
Average of Storm Peaks (cfs)	606.087	633.429
Baseflow Recession Rate	0.980	0.910
Total Interflow	0.060	
Total Surface Runoff	10.430	
Summer Flow Volume	7.910	6.635
Winter Flow Volume	2.720	2.433
Summer Storm Volume	6.600	5.065
Error in total volume	8.900	
Error in low flow recession	-0.070	
Error in 50% lowest flows	-1.800	
Error in 10% highest peaks	5.300	
Error in storm peaks	-4.300	
Seasonal volume error	7.400	
summer storm volume error	22.900	

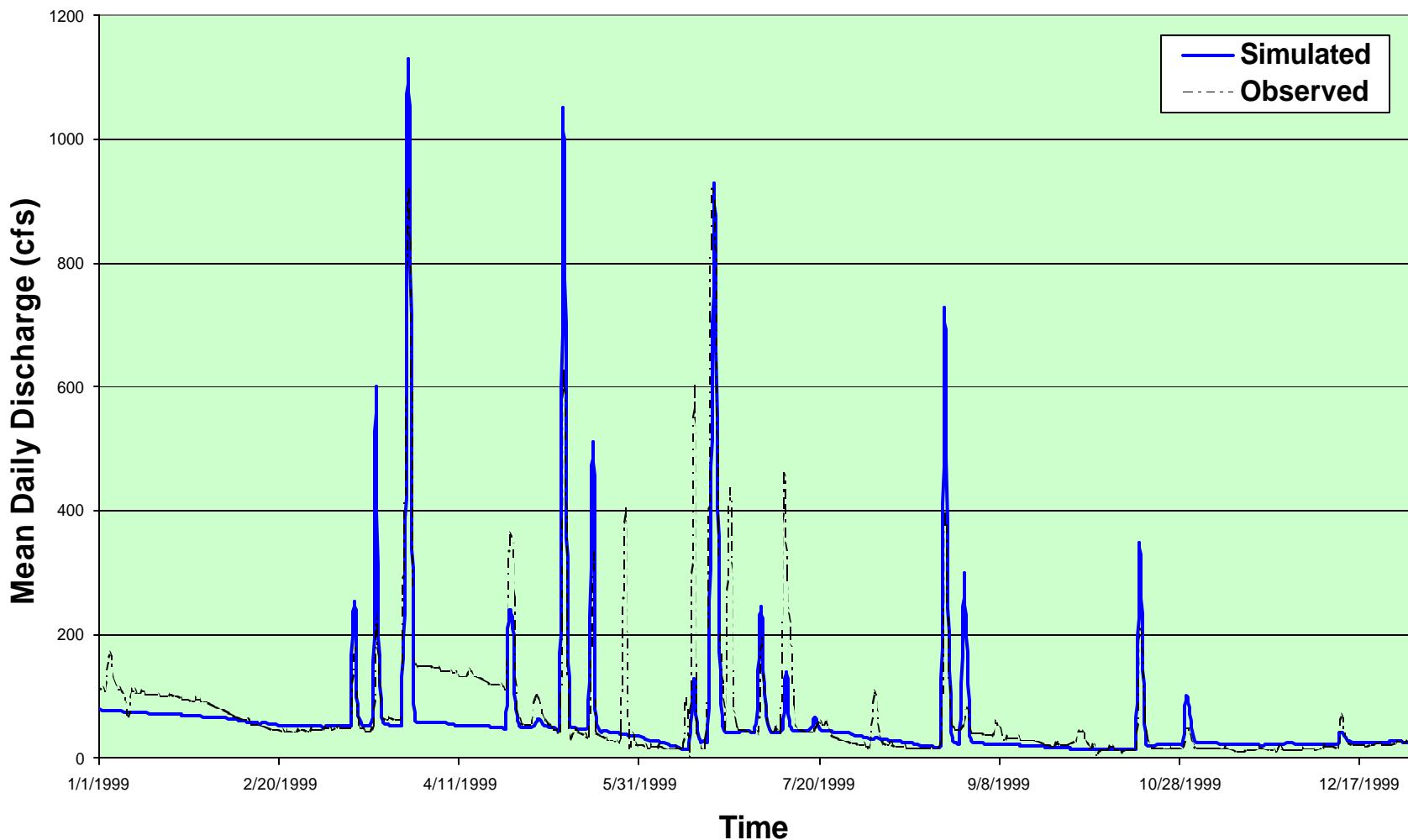


Mean Daily Discharge for Calibration Years 1998-2002 – Loop 410 - Upper San Antonio





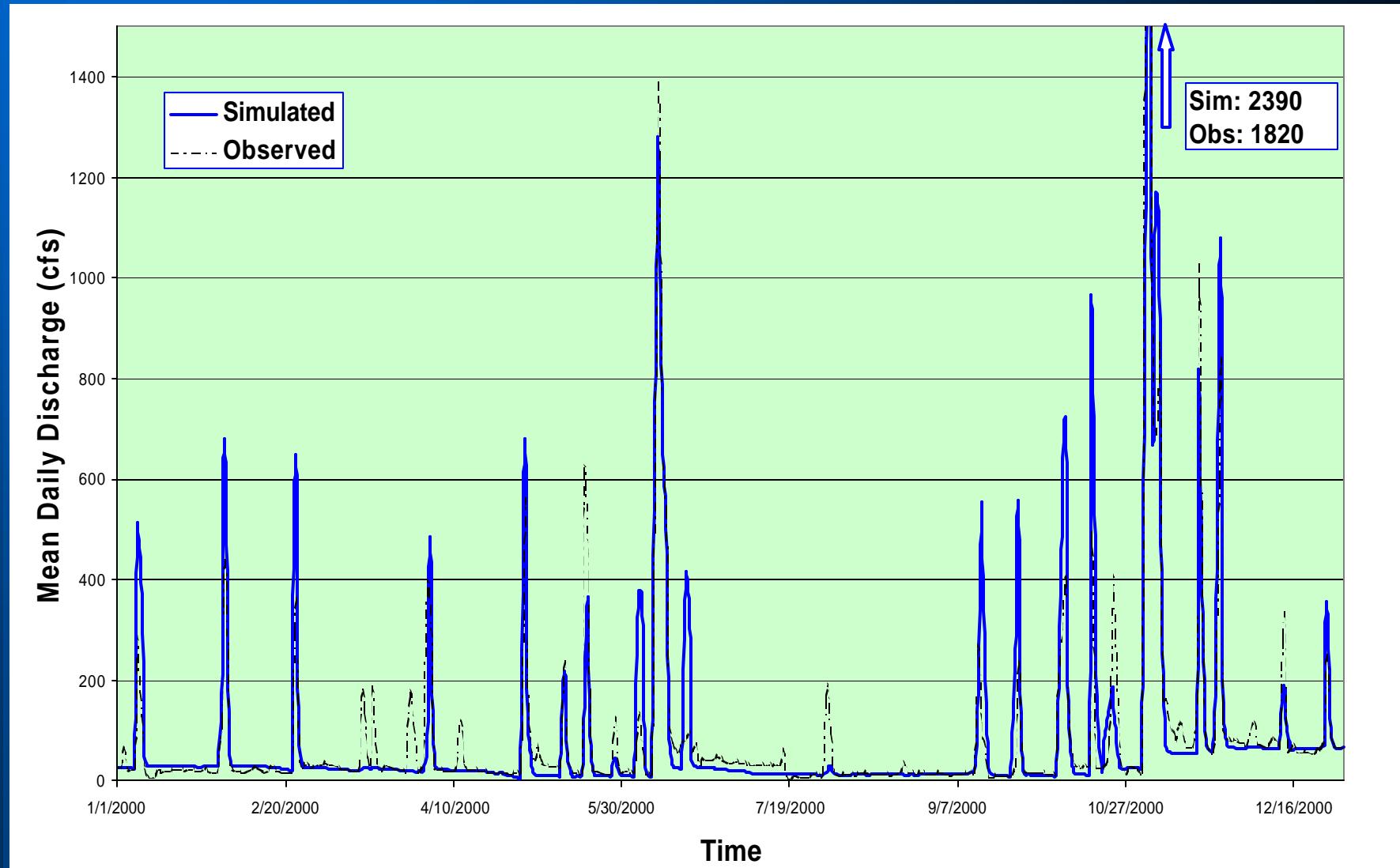
Mean Daily Discharge for Calibration Year 1999 Loop 410 - Upper San Antonio





Mean Daily Discharge for Calibration

Year 2000 – Loop 410 - Upper San Antonio





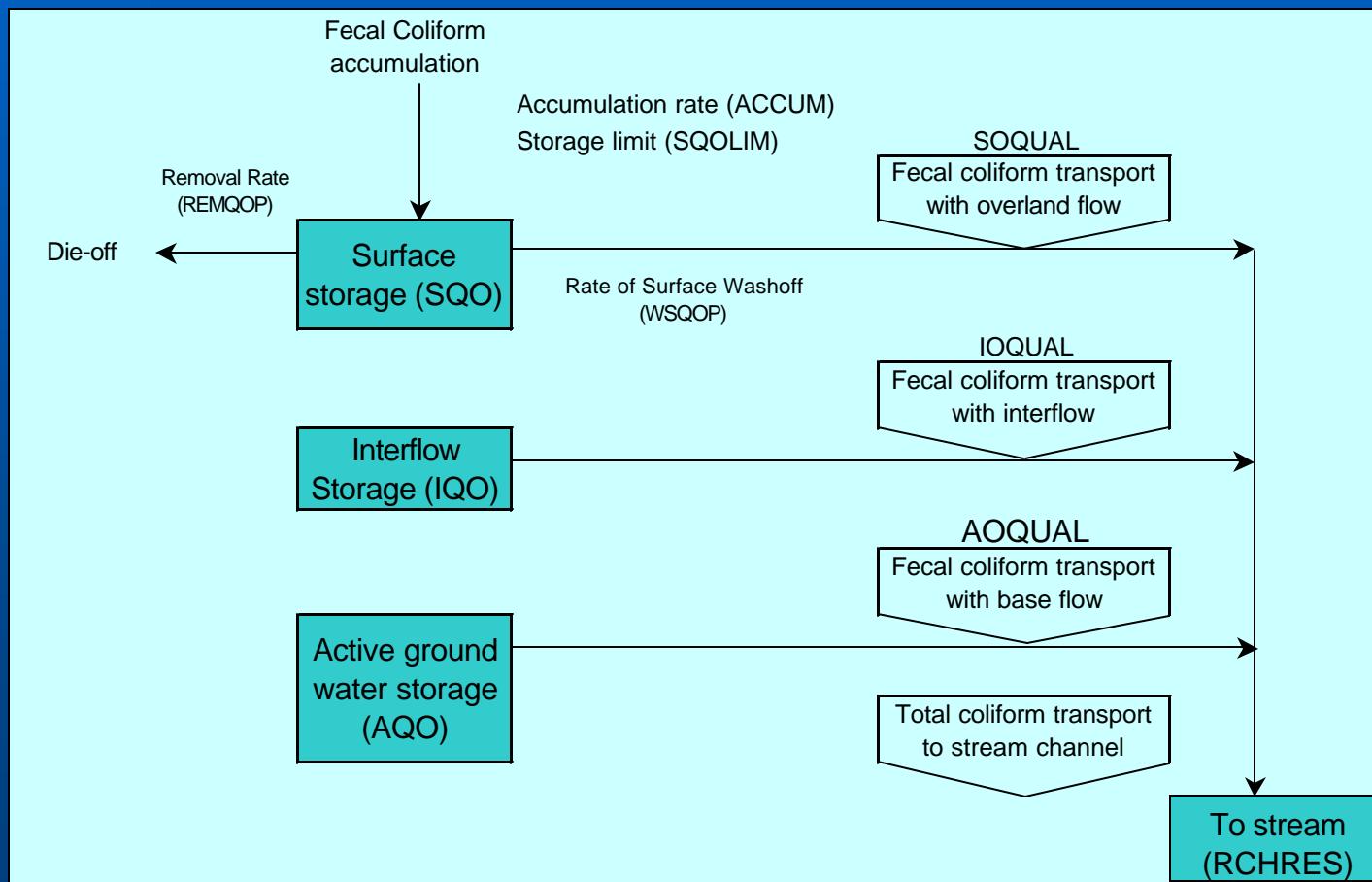
HSPF Calibration Output

USAR, Loop 410

	Simulated	Observed
Total Runoff (in)	74.520	76.539
Total of Highest 10% Flows	48.200	43.551
Total of Lowest 50% Flows	7.150	7.188
Evapotranspiration	106.700	293.500
Total Storm Volume	25.810	22.450
Average of Storm Peaks (cfs)	1149.855	1006.000
Baseflow Recession Rate	0.990	0.960
Total Interflow	0.480	
Total Surface Runoff	38.840	
Summer Flow Volume	19.270	16.643
Winter Flow Volume	12.660	14.799
Summer Storm Volume	12.570	9.660
Error in total volume	-2.600	
Error in low flow recession	-0.030	
Error in 50% lowest flows	-0.500	
Error in 10% highest peaks	10.700	
Error in storm peaks	14.300	
Seasonal volume error	30.300	
summer storm volume error	15.100	



HSPF Bacteria Simulation





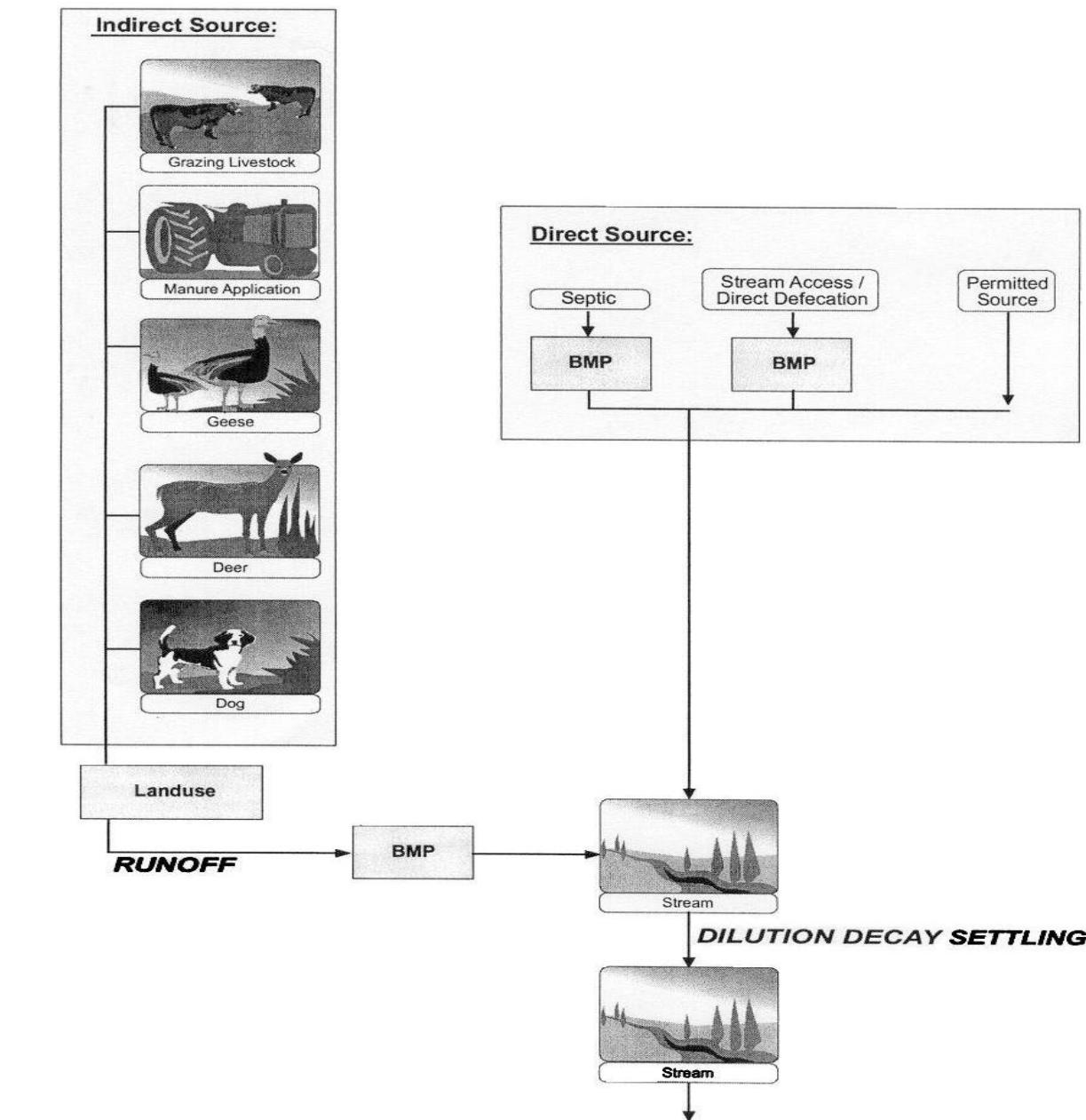
Fecal Sources Considered in Modeling Analysis

- Direct Sources
 - Failing septic systems
 - Direct wildlife contributions
 - Direct livestock contributions
 - Leaking sewer lines (implicit)
- Rangeland, Forestland
 - Wildlife (deer, raccoon, opossum, ducks, feral hogs)
 - Livestock (cattle, horses/donkeys, sheep/goats, hogs)
- Cropland
 - Wildlife (deer, raccoon, opossum, ducks, feral hogs)
- Urban (residential, commercial/industrial)
 - General urban sources and loading factors



Fecal Coliform Accumulation Rate Development

Summary of Fecal Coliform Sources





Wildlife and Livestock as Direct Sources

Example Calculation:

$$\# \text{ of deer in streams} = \left(\frac{\# \text{ of deer}}{\text{acre of SW}} \right) \times (\text{SW area in acres}) \times \left(\frac{\text{time spent in stream}}{\text{time spent in SW}} \right)$$

$$\# \text{ of cattle in riparian zone} = \left[\text{cattle density} \left(\frac{\text{cows}}{\text{acre}} \right) \right] \times [\text{watershed area in acres}] \times \left[\frac{\text{riparian area}}{\text{subwatershed area}} \right]$$

$$\# \text{ of cows in streams} = (\# \text{ of cows in the riparian zone}) \times (\% \text{ of time unconfined}) \times (\% \text{ of time in streams})$$

Once the specific animal counts are determined, hourly loading rates are calculated as follows:

$$\text{Fecal Coliform Loading Rate } \left(\frac{\text{count}}{\text{hour}} \right) = \frac{(\# \text{ of animals in streams}) \times (\text{production rate}) \left(\frac{\text{count}}{\text{animal - day}} \right)}{24 \text{ hours/day}}$$



Wildlife and Livestock as Non-Point Sources

Example Calculation:

of deer contributing to washoff = $\left(\frac{\# \text{ of deer}}{\text{acre of SW}} \right) \times (\text{SW area in acres}) - (\# \text{ of deer in streams})$

of cows contributing to washoff = $\left(\frac{\# \text{ of cows}}{\text{acre of SW}} \right) \times (\text{SW area in acres}) - (\# \text{ of cows in streams}) - (\# \text{ of cows confined})$

Once the specific animal counts are determined,
monthly accumulation rates are calculated as follows:

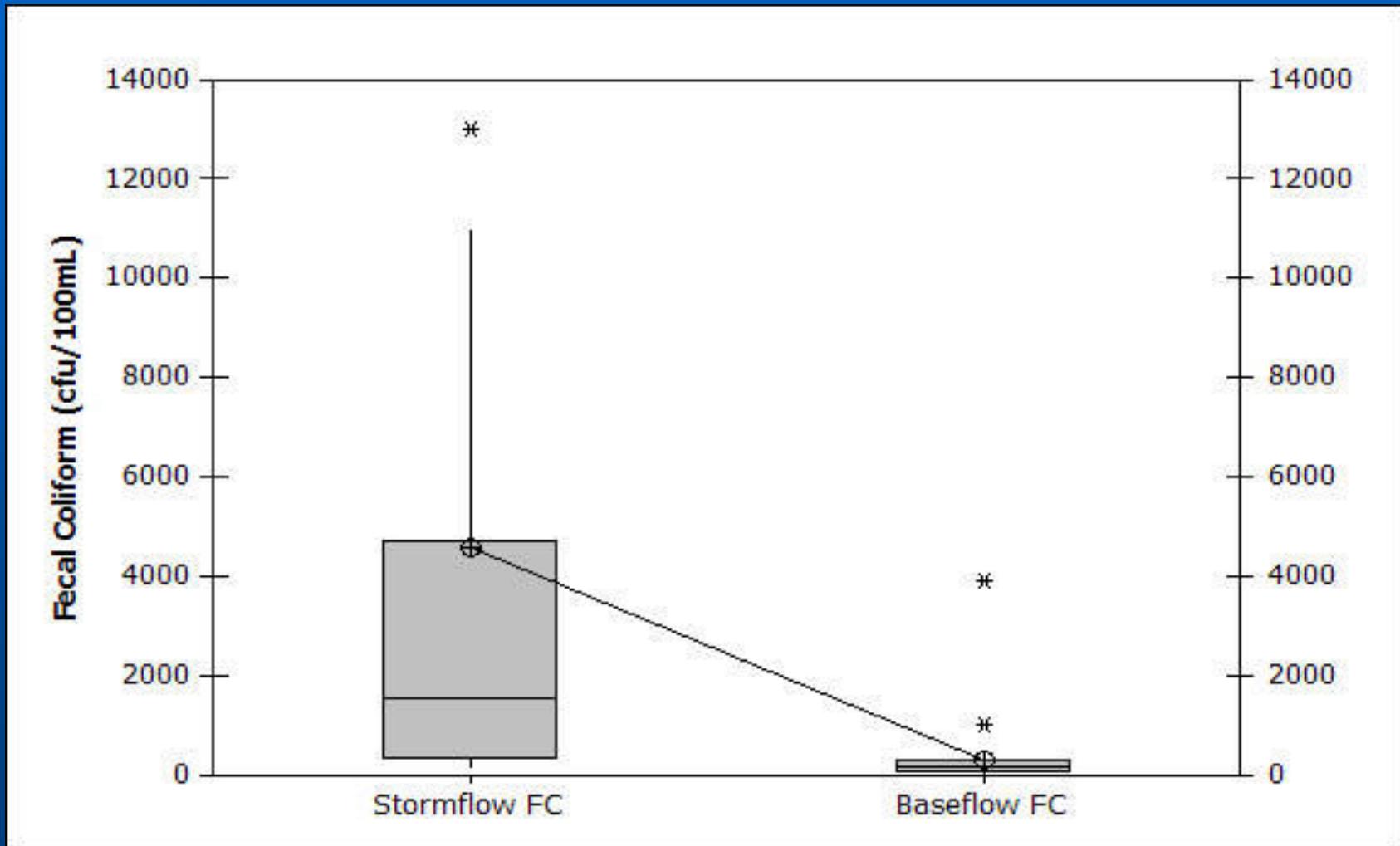
Fecal Coliform Loading Rate $\left(\frac{\text{count}}{\text{acre-day}} \right) = \frac{(\# \text{ of animals contributing to washoff}) \times (\text{production rate}) \left(\frac{\text{count}}{\text{animal-day}} \right)}{\text{acres of watershed}}$



Salado Creek at Loop 13

Boxplot of Runoff vs. Baseflow

Note: a value of 38,000 cfu/100mL omitted to preserve plot scale





Salado Creek Model Calibration for Fecal Coliform Runoff Events

Station Location	Model Location	Observed Data Median Values (Col/100 mL)	Simulated Data Median Values (Col/100 mL)
Loop 410NE	RCH 49	7861	1390
Hwy 368	RCH 52	2700	2090
Woodburn	RCH 53	2600	3275
Commerce	RCH 57	1760	1210
Rigsby	RCH 72	2160	4750
Loop 13	RCH 74	1575	1560

Salado Creek Model Calibration for Fecal Coliform Baseflow Conditions



Station Location	Model Location	Observed Data Median Values (org/100 mL)	Simulated Data Median Values (org/100 mL)
Loop 410NE	RCH 49	28	64
Hwy 368	RCH 52	135	34
Woodburn	RCH 53	166	153
Commerce	RCH 57	124	74
Rigsby	RCH 72	140	208
Loop 13	RCH 74	160	164



Salado Creek Watershed Direct Sources By Reach

Upper Reach		Outer Reach		Central Reach	
RCHRES	Fecal Coliform (10^6 count/day)	RCHRES	Fecal Coliform (10^6 count/day)	RCHRES	Fecal Coliform (10^6 count/day)
33	432	4	936	51	110
34	888	5	312	50	13
39	1272	6	432	52	175
29	1608	46	1128	15	3648
1	696	7	840	14	28080
32	1608	8	1152	53	22032
2	816	9	936	54	77760
44	672	10	840	55	29376
30	912	13	1680	56	47520
40	1200	11	1128	17	21168
3	312	20	312	16	43200
31	648	23	1104	57	10800
41	816	12	26	58	60480
43	792	49	20	72	38016
38	408			73	86400
48	696			74	28944
42	223			75	69120
47	480			21	324000
45	936				
37	888				
35	1488				

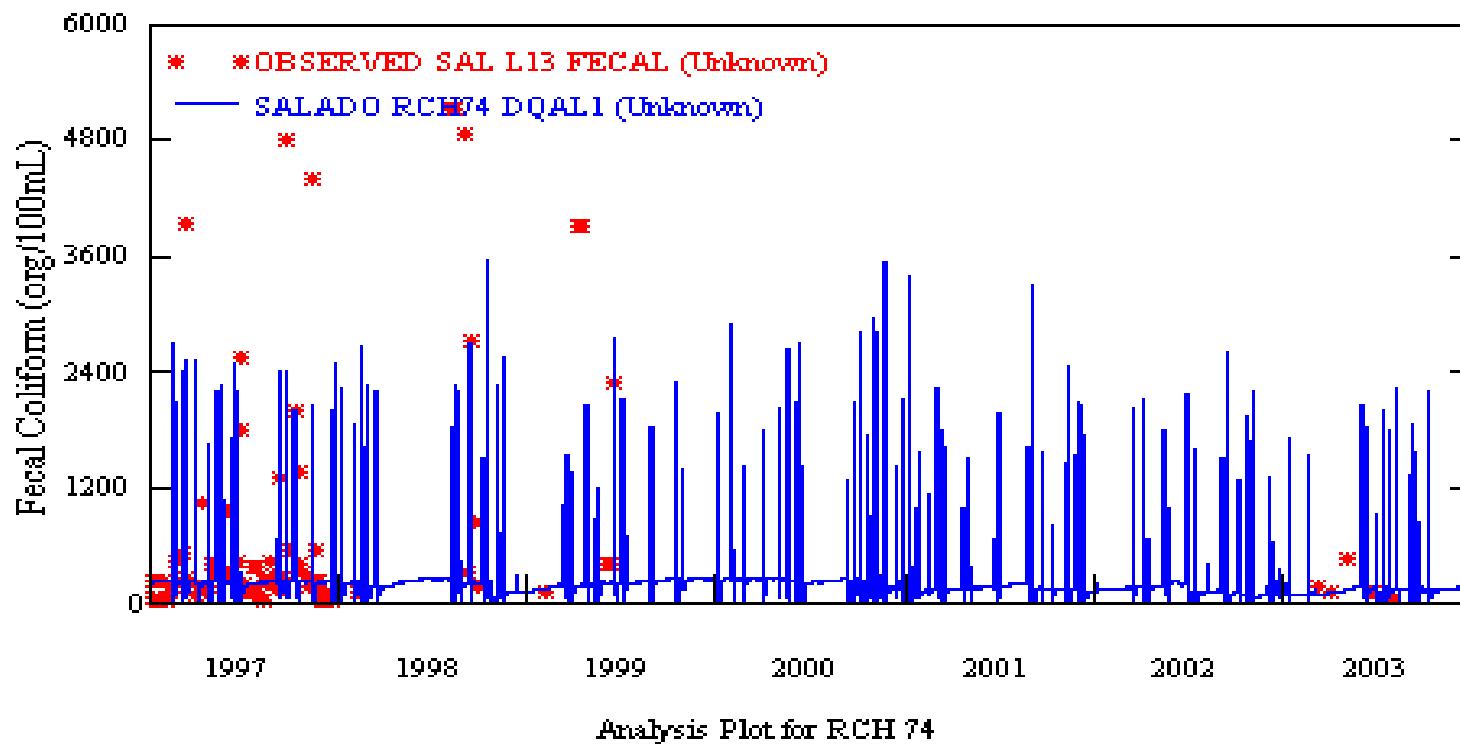


Salado Watershed Loading Rates by Land Use

Upper Reach			Outer Reach		
Description	ACQOP (10^6 counts/ac/day)	SQOLIM (10^6 counts/ac)	Description	ACQOP (10^6 counts/ac/day)	SQOLIM (10^6 counts/ac)
Forest_Rech_Upper	14000	25000	Forest_Rech_Outer	140000	250000
Comm_Ind_Rech_Upper	12	22	Comm_Ind_Rech_Outer	650	1150
Resident_Rech_Upper	12	22	Resident_Rech_Outer	650	1150
Rangeland_Rech_Upper	13000	24000	Rangeland_Rech_Outer	130000	240000
Forest_Non_Rech_Upper	14000	25000	Forest_Non_Rech_Out	140000	250000
Comm_Ind_Non_Rech_Up	12	22	Com_Ind_Non_Rech_Out	650	1150
Resident_Non_Rech_Up	12	22	Res_Non_Rech_Outer	650	1150
Rangeland_Non_Rech_U	13000	24000	Range_Non_Rech_Outer	130000	240000
Com_Ind_Rech_Upper	12	22	Res_Non_Rech_Outer	650	1150
Res_Recharge_Upper	12	22	Com_Ind_Non_Rech_Out	650	1150
Res_Non_Rech_Upper	12	22	Com_Ind_Rech_Outer	650	1150
Com_Ind_Non_Rech_Up	12	22	Res_Recharge_Outer	650	1150
Central Reach			Walzem Creek		
Description	ACQOP (10^6 counts/ac/day)	SQOLIM (10^6 counts/ac)	Description	ACQOP (10^6 counts/ac/day)	SQOLIM (10^6 counts/ac)
Forest_Non_Rech_Cent	39000	70000	Comm_Indust_Walzem	1200	2100
Com_Ind_Non_Rech_Cen	24000	42000	Residential_Walzem	1200	2100
Res_Non_Rech_Central	24000	42000	Rangeland_Walzem	3900	7000
Range_Non_Rec_Centra	39000	70000	Residential_Walzem	6000	11000
Res_Non_Rech_Central	24000	44000	Com_Indust_Walzem	6000	11000
Com_Ind_Non_Rech_Cen	24000	44000			

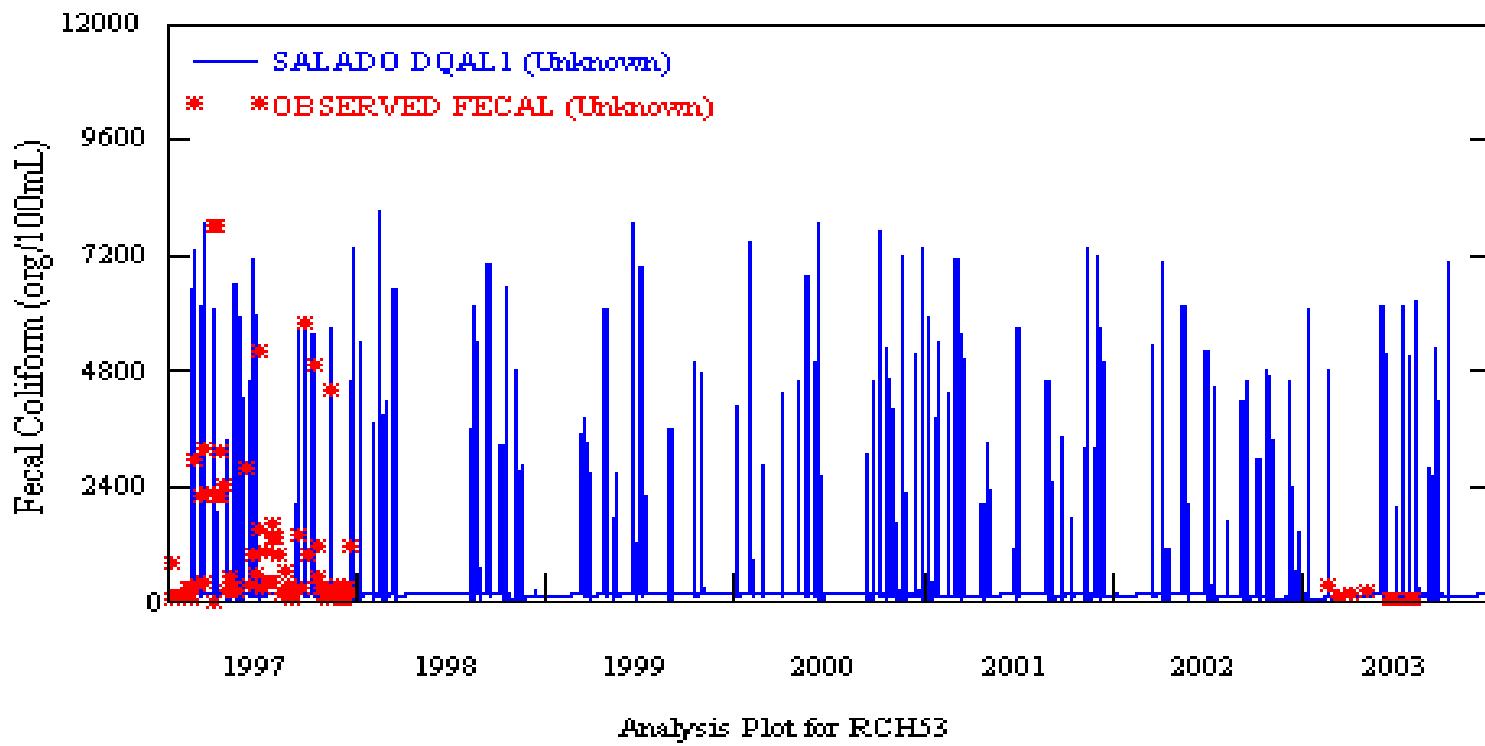


Simulated and Observed Fecal Coliform at Loop 13, Salado



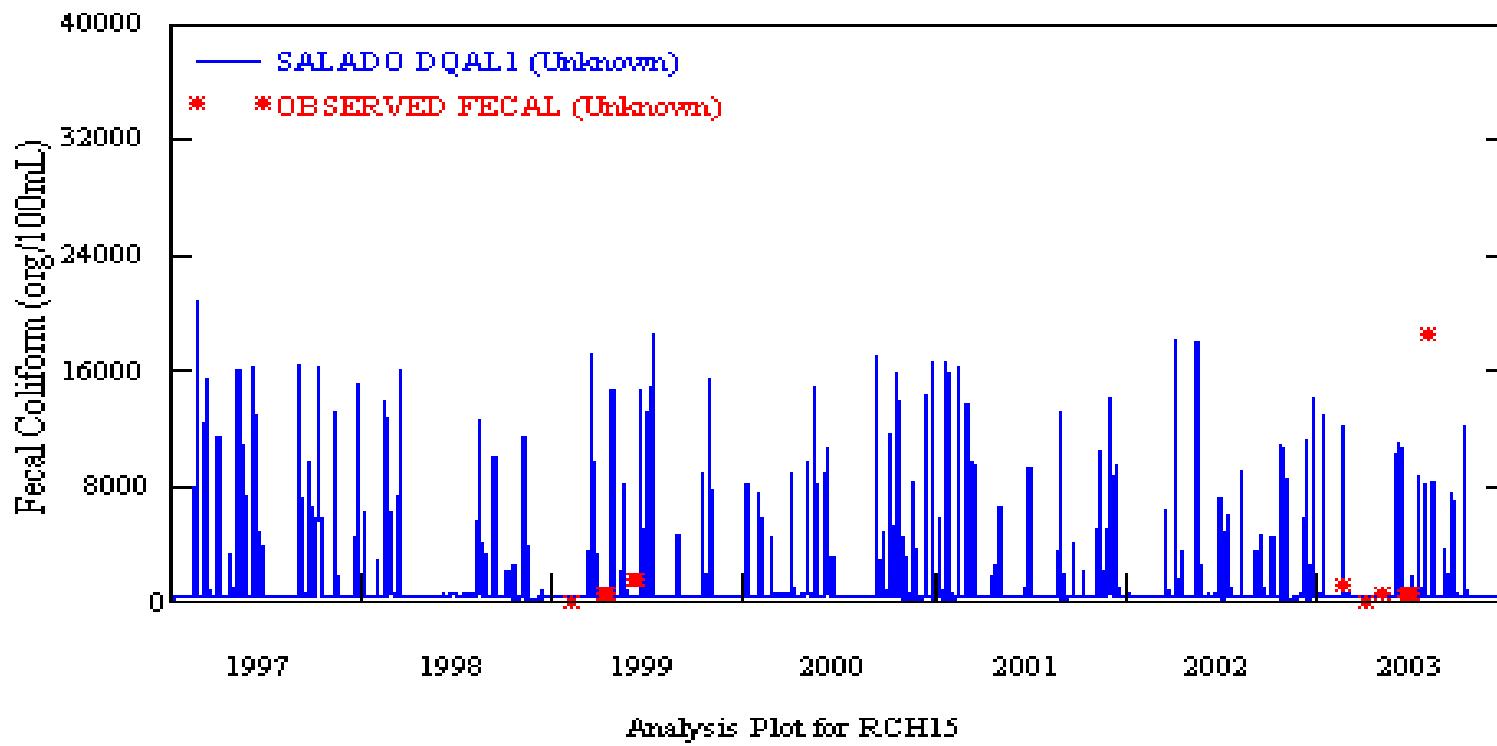


Simulated and Observed Fecal Coliform at Woodburn St., Salado



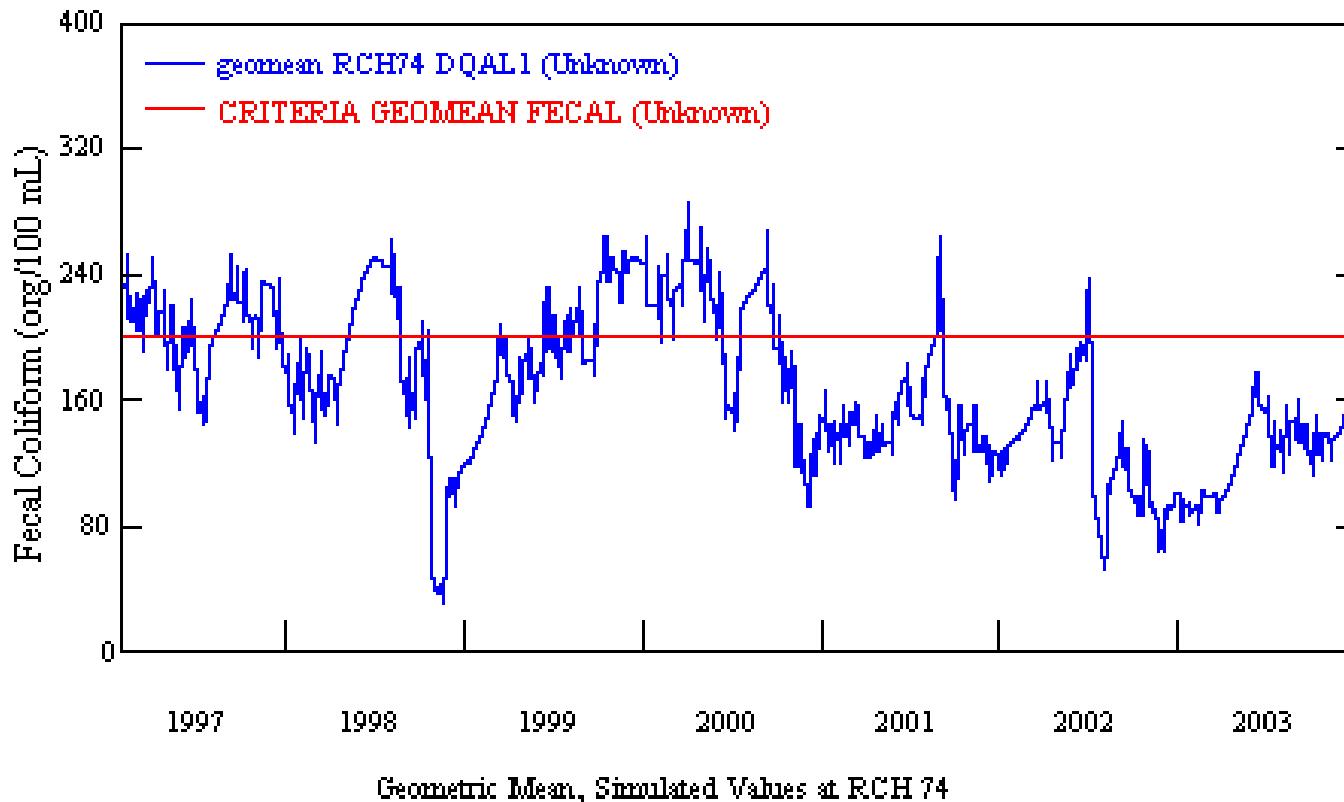


Simulated and Observed Fecal Coliform at Walzem Creek

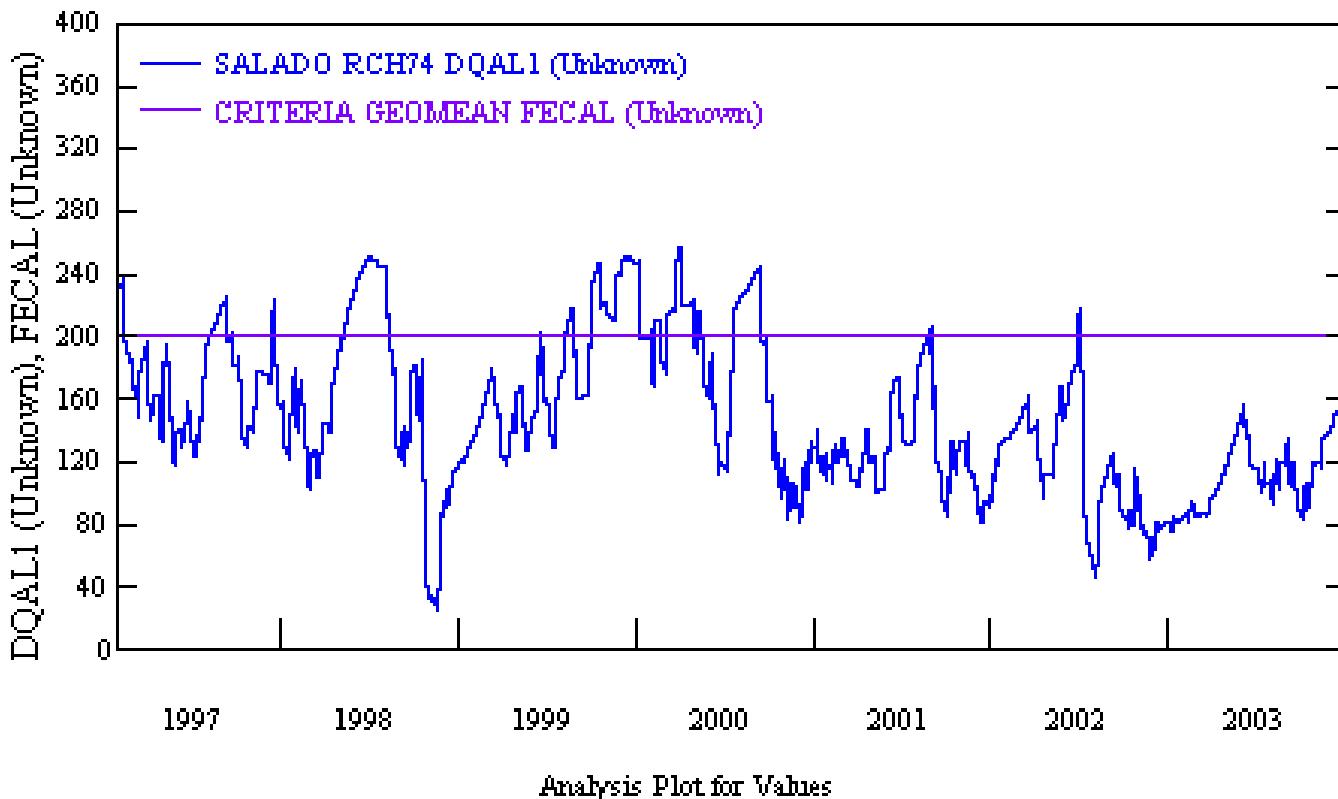




Salado Allocation: Geometric Mean, Simulated Daily Values

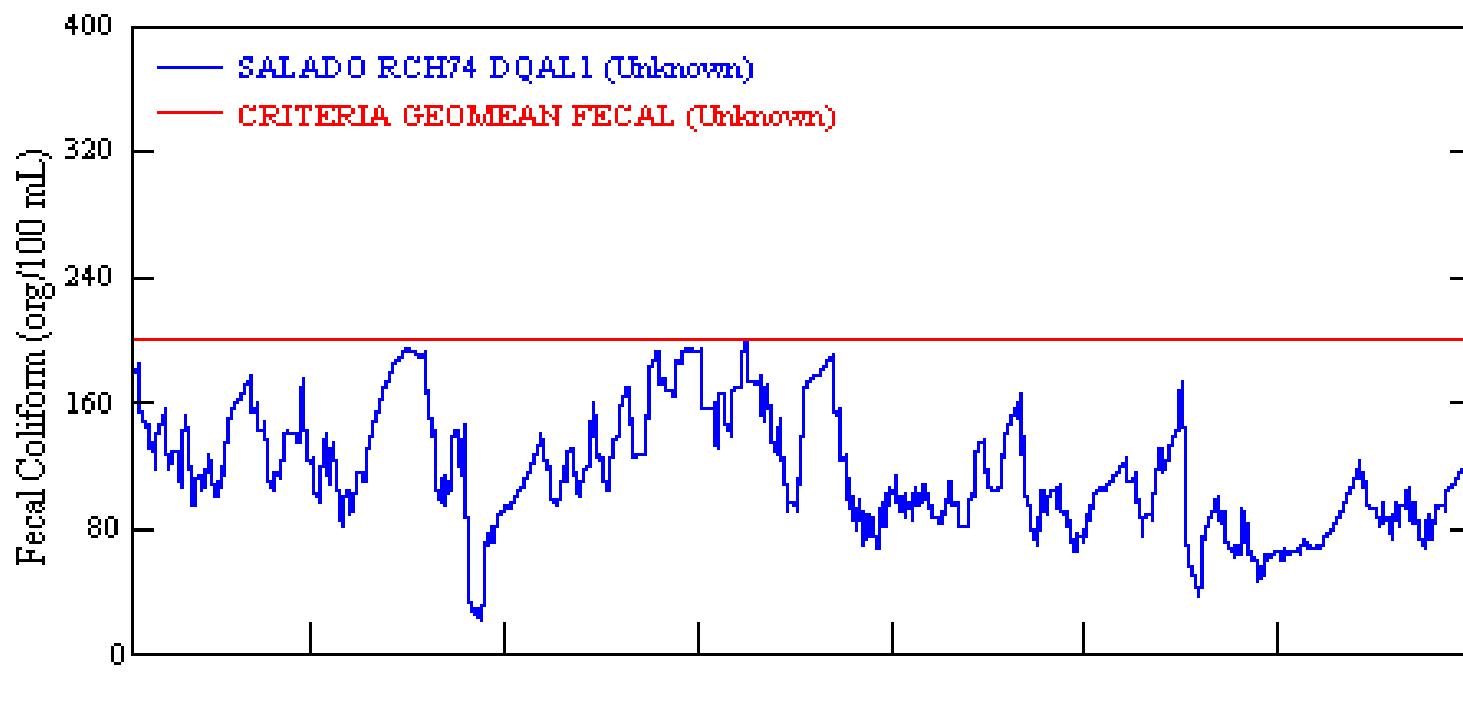


Salado Allocation: 90% Reduction in Residential and Commercial PERLND\$ & IMPLND\$ for Central Reach





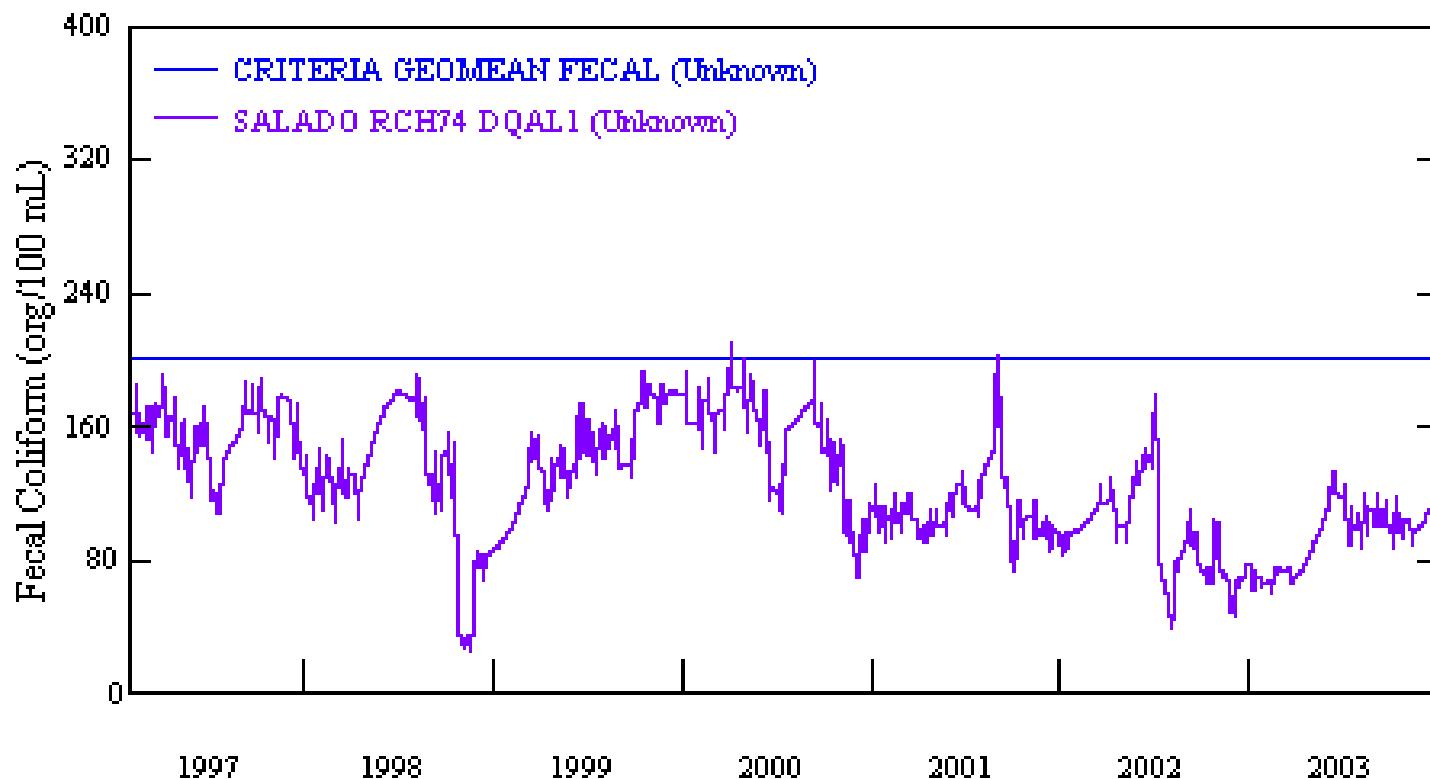
Salado Allocation: 90% Reduction in IMPLNDS & PERLNDS, 23% Reduction in Direct Sources for Central Reach



Analysis of Geometric Mean, RCH 74, Reductions



Salado Allocation: 30% Reduction in Direct Sources



Analysis of Geometric Mean, RCH 74, Reductions to Direct Sources



San Antonio River Model Calibration for Fecal Coliform Runoff Events

Station Location	Model Location	Observed Data Median Values (org/100 mL)	Simulated Data Median Values (org/100 mL)
Alamo	RCH 62	1170	1570
Mitchell	RCH 67	7500	1485
Loop 410	RCH 71	430	1485
IH 37	RCH 78	3180	1405
FM 791	RCH 28	500	1430

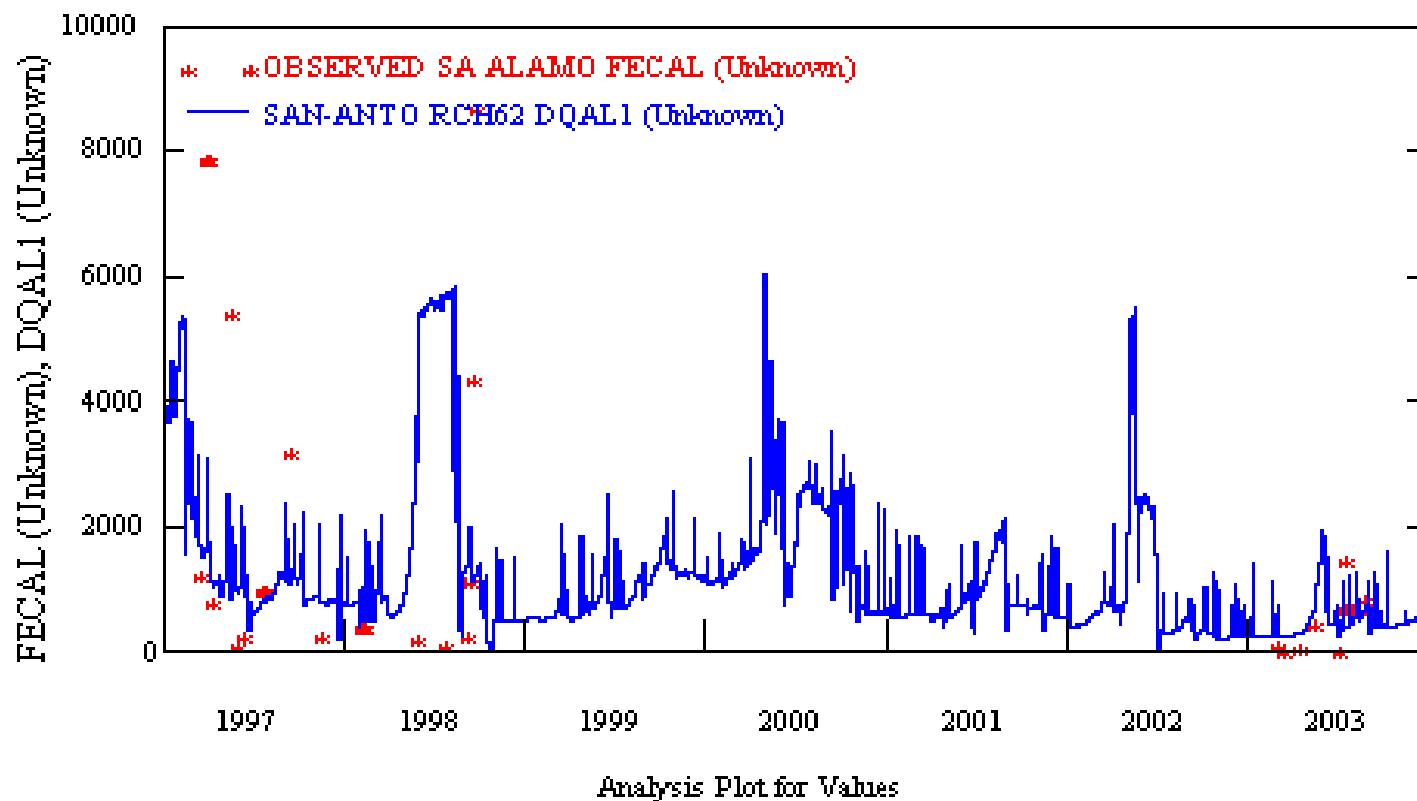


San Antonio River Model Calibration for Fecal Coliform Baseflow Events

Station Location	Model Location	Observed Data Median Values (org/100 mL)	Simulated Data Median Values (org/100 mL)
Alamo	RCH 62	242	555
Mitchell	RCH 67	295	374
Loop 410	RCH 71	96	144
IH 37	RCH 78	100	15
FM 791	RCH 28	70	619

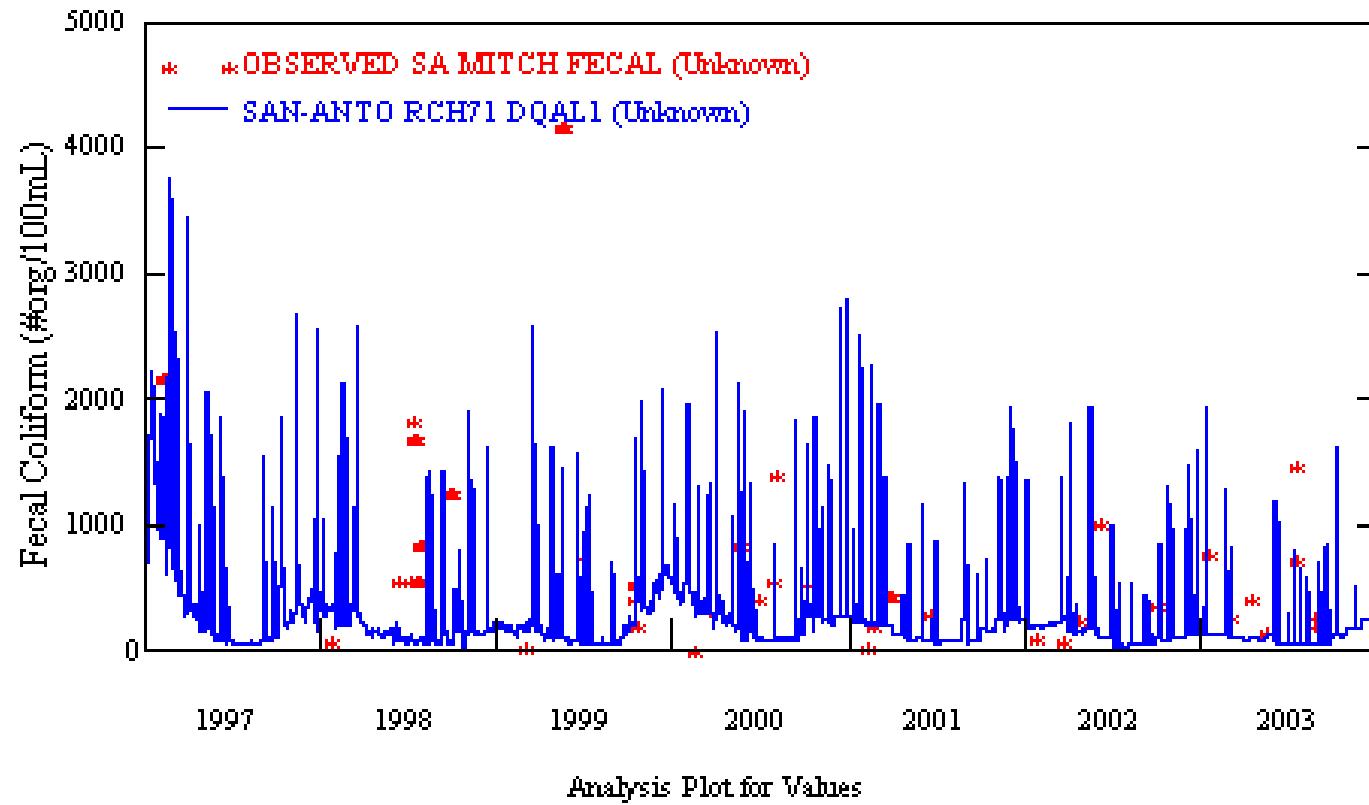


Simulated and Observed Fecal Coliform at Alamo St., USAR



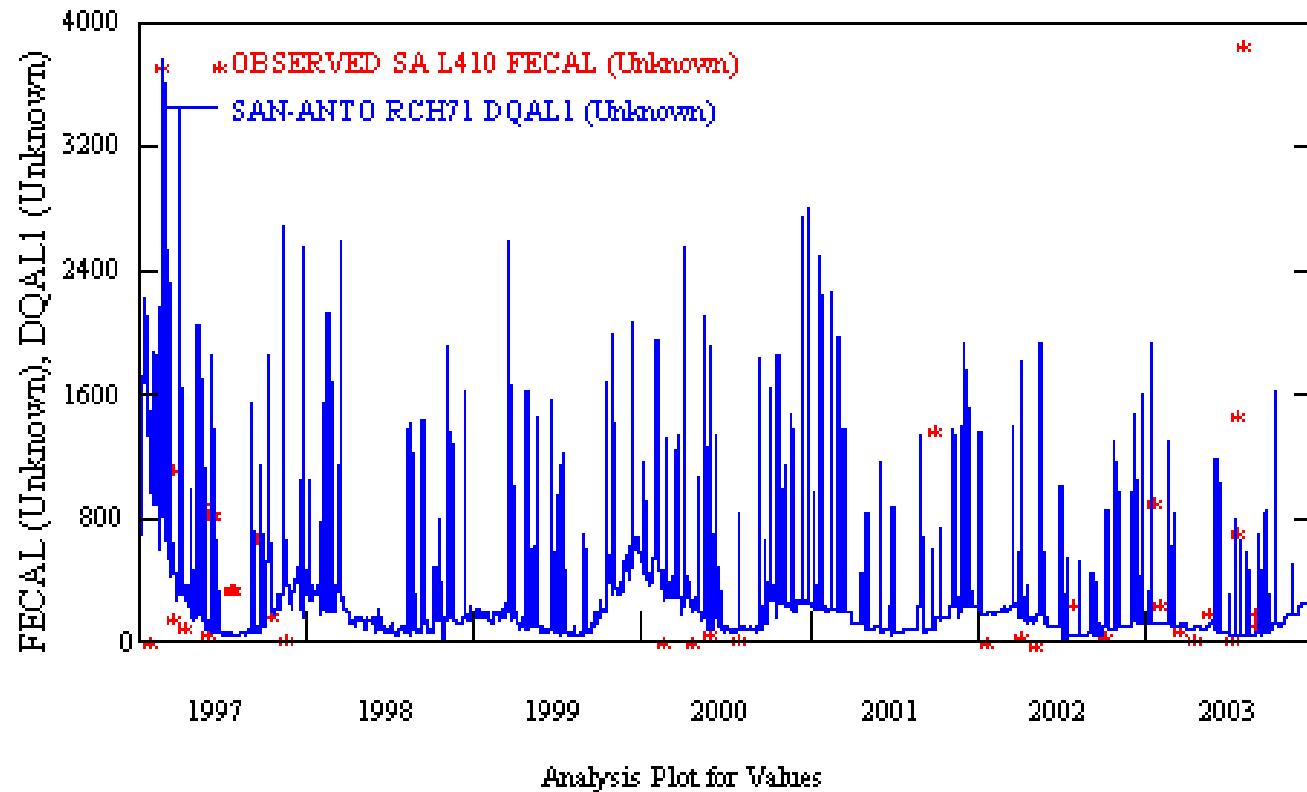


Simulated and Observed Fecal Coliform at Mitchell St., USAR



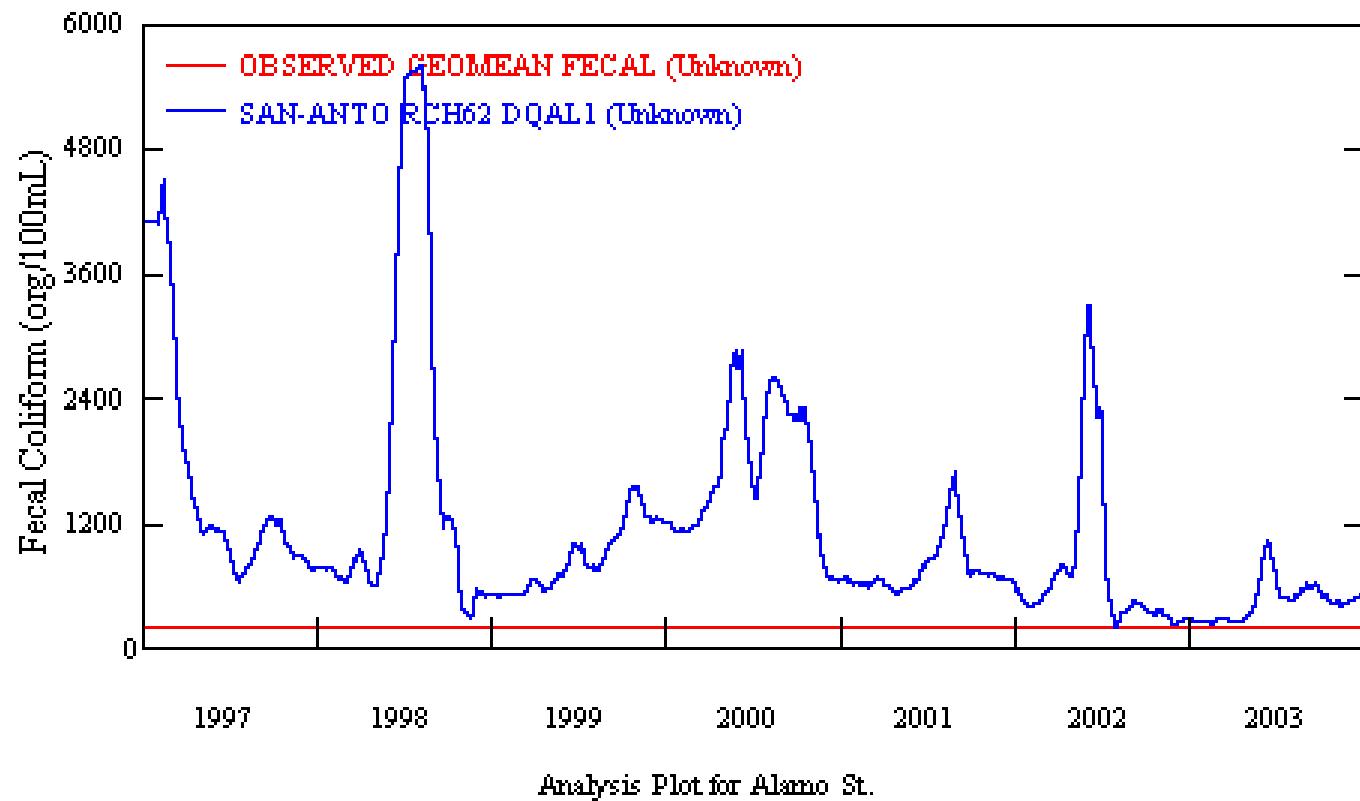


Simulated and Observed Fecal Coliform at Loop 410, USAR



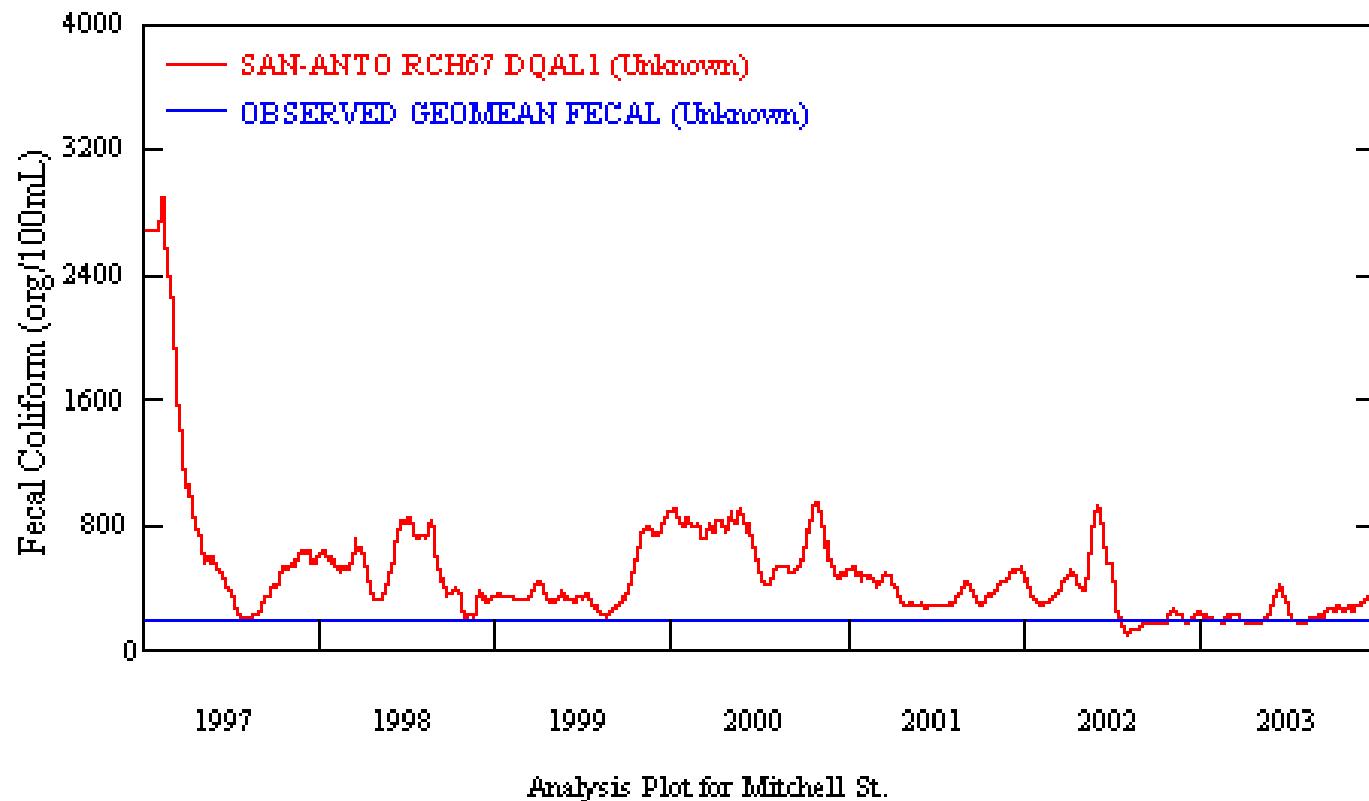


USAR Allocation: Geometric Mean, Simulated Daily Values





USAR Allocation: Geometric Mean, Simulated Daily Values





Next Steps

1. Complete the loading allocation
2. Submit draft report to TCEQ
3. TCEQ prepare TMDL



Questions / Comments ?